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Prepared in cooperation with the Imperial Irrigation District

Year 3 Summary Report: Baseline Selenium Monitoring of Agricultural Drains Operated by the Imperial Irrigation District in the Salton Sea Basin

Open-File Report 2008-1271

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Conversion Factors

Multiply	By	To obtain
millimeter (mm)	0.03937	inch (in.)
kilometer (km)	0.6214	mile (mi)
liter (L)	33.82	ounce, fluid (fl. oz)
gram (g)	0.03527	ounce, avoirdupois (oz)
cubic hectometer (hm^3)	810.7	acre-foot (acre-ft)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
°F=(1.8×°C)+32.

Specific conductance is given in millisiemens per centimeter at 25 degrees Celsius (mS/cm at 25°C).
Concentrations of chemical constituents in water are given either in micrograms per milliliter (µg/L) or micrograms per liter (µg/L).

Year 3 Summary Report: Baseline Selenium Monitoring of Agricultural Drains Operated by the Imperial Irrigation District in the Salton Sea Basin

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Abstract

This report summarizes findings from the third year of a 4-year-long field investigation to document selected baseline environmental conditions in 29 agricultural drains and ponds operated by the Imperial Irrigation District along the southern border of the Salton Sea. Routine water quality and fish species were measured at roughly quarterly intervals from April 2007 to January 2008. The water quality measurements included total suspended solids and total (particulate plus dissolved) selenium. In addition, during April and October 2007, water samples were collected from seven intensively monitored drains for measurement of particulate and dissolved selenium, including inorganic and organic fractions. In addition, sediment, aquatic food chain matrices (particulate organic detritus, filamentous algae, net plankton, and midge [chironomid] larvae), and two fish species (western mosquitofish, *Gambusia affinis*; and sailfin molly, *Poecilia latipinna*) were sampled from the seven drains for measurement of total selenium concentrations. The mosquitofish and mollies were intended to serve as surrogates for desert pupfish (*Cyprinodon macularius*), an endangered species that we were not permitted to take for selenium determinations. Water quality values were typical of surface waters in a hot desert climate. A few drains exhibited brackish, near anoxic conditions especially during the summer and fall when water temperatures occasionally exceeded 30°C. In general, total selenium concentrations in water varied directly with conductivity and inversely with pH. Although desert pupfish were found in several drains, sometimes in relatively high numbers, the fish faunas of most drains and ponds were dominated by nonnative species, especially red shiner (*Cyprinella lutrensis*), mosquitofish, and mollies. Dissolved selenium in water samples from the seven intensively monitored drains ranged from 0.700 to 24.1 µg/L, with selenate as the major constituent in all samples. Selenium concentrations in other matrices varied widely among drains and ponds, with at least one drain (for example, Trifolium 18) exhibiting especially high concentrations in food chain organisms (in detritus, 13.3–28.9 µg Se/g; in net plankton, 11.9–19.3 µg Se/g; in midge larvae, 12.7–15.4 µg Se/g) and fish (in mollies, 12.8-25.1 µg Se/g; in mosquitofish, 13.2-20.2 µg Se/g; all concentrations are dry weights). These elevated concentrations approached or exceeded average concentrations reported from flowing waters in seleniferous wetlands in the San Joaquin Valley.

Introduction

The Imperial Irrigation District (IID) operates and maintains many agricultural drains in the Imperial Valley of California, some of which discharge directly into the Salton Sea. Agricultural practices, such as water management and conservation, affect the quality of drain water. The desert pupfish (*Cyprinodon macularius*), a federally listed endangered species, occurs in some of these drains.

In October 2003, the IID entered into agreements with the Bureau of Reclamation, State of California, and three local water agencies in southern California (henceforth referred to as “conservation partners”) to reduce the amount of water removed from the Colorado River to 5,425.2 hm^3 (4.4 million acre-feet), the State’s normal-year entitlement. One of these agreements, the Quantification Settlement Agreement (*http://www.crss.water.ca.gov/crqsa/index.cfm*), contains a plan to transfer up to 372.69 hm^3 (303,000 acre-feet) of conserved agricultural water from the IID service area to the southern California coast and Coachella Valley. However, resource managers are concerned that water conservation efforts will reduce the amount of wetland habitat associated with canals and drains in the IID service area. In addition, water quality in the wetland habitat could be adversely affected by increased concentrations of dissolved minerals, including trace elements such as selenium. Although required in small amounts by many animals, abnormally high concentrations of selenium can be toxic (Lemly, 2002).

In July 2005, the U.S. Geological Survey (USGS) Western Fisheries Research Center (WFRC), in collaboration with the USGS Columbia Environmental Research Center (CERC), was contracted to conduct a multi-year baseline selenium monitoring program on as many as 32 agricultural drains operated by IID that support or potentially support desert pupfish. However, after a preliminary field reconnaissance visit to the 32 drains, a final list of 29 active drains (includes three pond-like habitats) was identified for monitoring.

The purpose of the selenium monitoring project is to characterize physical and chemical baseline conditions in representative agricultural drains operated by IID, with emphasis on selenium concentrations in water, sediment, dietary components of desert pupfish, and in tissues of selected surrogate fish species. The monitoring project is divided into an extensive monitoring task (sampling all 29 drains or ponds) and an intensive monitoring task (sampling seven of the 29 drains or ponds). The seven intensively monitored drains were selected to include a broad range of selenium exposures (from low to high) as determined by total selenium concentrations measured in unfiltered water samples.

Specific objectives of the project are: (1) to document selenium concentrations in water, sediment, dietary components of desert pupfish, and tissues of surrogate fish species such as western mosquitofish (*Gambusia affinis*) or sailfin molly (*Poecilia latipinna*) if mosquitofish is not available; and (2) to document other environmental variables such as water quality, total suspended solids, and sediment particle size. In addition, although not specifically identified in the contract, USGS will document the incidental capture of any pupfish during supplemental monitoring of fish species in the drains.

Data from earlier field work at the 29 extensively monitored drains or ponds were summarized in Summary Reports for Years 1 and 2 (see Saiki, 2006, 2007). Details on laboratory analytical techniques and quality control results presented in these reports were described by May and others (2006a, 2006b, 2007a). In March 2006, the IID Implementation Team (IT) used results in the Year 1 Summary Report to select the seven drains (Trifolium 20, Poe, Trifolium 18, Trifolium 14, O, T, and Z-Spill) for intensive monitoring. In addition, the IT determined that intensive monitoring would occur in April and October of each year, beginning in April 2006.

This report covers findings from the third year of field work. Field work was conducted during April 17–May 3, July 12-13, and October 11-24, 2007, and January 10-15, 2008. However, other than to describe some general patterns and statistical relations, this report does not compare the results with previous findings or provide in-depth ecotoxicological interpretations. Instead, a more thorough assessment and interpretation of field data will be provided in the final report for this project. As part of the final report, we plan to compare our data with anticipated findings from laboratory toxicological studies on desert pupfish conducted by other CERC investigators, with the intent to "…facilitate the informed application of management measures and actions to protect desert pupfish populations and habitat in IID drains (Imperial Irrigation District, 2004)." Collectively, the field and laboratory projects address a requirement of the 2002 Fish and Wildlife Service Biological Opinion, which directs the Bureau of Reclamation and its conservation partners to fund a study to determine the impacts of selenium on pupfish.

Study Area and Methods

The study area is located along the southern shore of the Salton Sea in Imperial County, California, about 140 km east of San Diego, 110 km west of Yuma, Arizona, and 45 km north of the U.S.-Mexico border (fig. 1). The 29 agricultural drains and ponds selected for study are (arranged loosely from west to east): Trifolium 23, San Felipe Wash, Trifolium 22, Former Trifolium 20, Trifolium 20, Trifolium 19, Poe, Trifolium 18, Trifolium Storm, Trifolium 1, Trifolium 14A, Trifolium 13, Trifolium 12, Lack & Lindsey Pond, Vail 5 (McKendry) Pond, Pumice Pond, O, P, Q, R, S, T, U, W, Z-Spill, Niland 1, Niland 2, Niland 3, and Niland 4 (table 1). Although Lack & Lindsey Pond, Vail 5 Pond, and Pumice Pond feature pool-like characteristics (that is, large open-water areas with little or no current flow), sample collection occurred at downstream reaches between the pooled water and the Salton Sea where opposite shorelines narrow considerably to form channels that resemble other agricultural drains and where current flow usually is noticeable.

Extensive Monitoring

As part of extensive monitoring, samples were collected from 22 drains and ponds during April and October 2007, and from 29 drains and ponds during July 2007 and January 2008. The drains and ponds were measured *in-situ* for routine water quality (temperature, dissolved oxygen, pH, specific conductance, and turbidity), and unfiltered water samples were collected for analysis of total suspended solids (TSS) and total selenium. All measurements and samples were made or collected from fixed stations located below the lowermost tile drain outlet (see table 1 for geospatial coordinates of fixed stations). At each station, water samples were collected first, followed by *in-situ* measurements of routine water quality. Finally, water depth was measured. During April only, 5 sediment samples were collected from each of 29 drains and ponds for field measurements of redox potential, pH, and temperature, and a single composite of the 5 samples was then submitted for laboratory measurements of particle size, total organic carbon (TOC), and total selenium. In addition to these samples and measurements, other miscellaneous station and site conditions were recorded while in the field, and each station was photographed. Although not part of the contracted work, we attempted to deploy as many as 10 baited minnow traps for 1 hour within each drain or pond to determine fish species composition and relative abundance.

Intensive Monitoring

During April and October 2007, seven drains (Trifolium 20, Poe, Trifolium 18, Trifolium 14, O, T, and Z-Spill; see fig. 1 for locations) were intensively monitored at fixed sampling stations by measuring total dissolved selenium from filtered water samples, and measuring total particulate selenium from nonfilterable residue obtained by the filtration process (see table 1 for geospatial coordinates of the fixed stations). Dissolved selenite and dissolved selenate also were measured from filtered water samples. Dissolved organic selenium was computed by subtracting the concentrations of dissolved selenite and dissolved selenate from the concentration of total dissolved selenium. Total selenium was computed by summing the concentrations of total dissolved selenium and total particulate selenium. In addition, composite samples of potential forage for desert pupfish (for example, detritus, filamentous algae, net plankton, and macroinvertebrates such as midge [Chironomidae] larvae; see Moyle [2002] for summary information on pupfish diets) were collected for analysis of total selenium. Whole-body composite samples of western mosquitofish and sailfin mollies that served as surrogates for desert pupfish were collected with minnow seines, dip nets, and unbaited minnow traps for analysis of total selenium. The minnow traps were not baited to avoid potential contamination by sodium selenite, which is an additive ingredient in some brands of fish-flavored cat food. Other samples collected during intensive monitoring (October only, because samples collected in April were part of extensive monitoring) included sediment for field measurements of redox potential, pH, and temperature, and laboratory measurements of particle size, TOC, and total selenium. The sampling design for collecting sediments in October was similar to that used during extensive monitoring.

In addition to collecting samples for selenium determinations, the seven drains were subjected to other sample collections and measurements typically made during extensive monitoring (for example, *in-situ* measurements of routine water quality; collection of unfiltered water samples for analysis of TSS; and surveys of fish species).

Water Quality Measurements

Routine measurements of water quality variables (temperature, dissolved oxygen concentration, pH, specific conductance, and turbidity) were made *in-situ* at 5-minute intervals with a Hydrolab Datasonde 4 multiprobe logger (Hach Environmental, Loveland, Colorado) over a roughly 1-hour time period at each of the 29 drains and ponds. The measurements were taken about 15 cm beneath the water surface at the fixed stations.

Fish Species Composition and Abundance

Fish were sampled for species composition and abundance from each of 29 drains or ponds by using as many as 10 minnow traps deployed about 5 m apart over a roughly 45-m reach that included the permanent station. (Note: This sampling effort was separate from fish collections made during intensive monitoring to collect western mosquitofish and sailfin mollies for selenium determinations.) Minnow traps measuring 25.4 × 25.4 × 43.2 cm with 3.2-mm mesh were baited with approximately 60 g of canned cat food (Special Kitty® "Tuna Dinner" Premium Cat Food, marketed by Wal-Mart Stores, Inc., Bentonville, Arkansas) held in a small plastic container (that is, a 35-mm photographic film canister) drilled with evenly spaced holes. Fishing effort for minnow traps was standardized at 1 hr to quantify the relative abundance of fish.

Captured fish were placed into plastic buckets filled with site water. Desert pupfish were measured for standard length and total length, then released alive in the capture vicinity. Nonnative fishes were identified and counted, then released alive in the capture vicinity.

Collection of Samples for Selenium and Other Determinations

The field procedures used to collect and temporarily store various sample matrices are briefly described below. Analytical procedures used by CERC for measuring selenium, TSS, sediment particle size distribution, and sediment TOC are reported under separate cover by May and others (2007b, 2008).

Unfiltered Water

Each water sample for determination of total selenium was poured through a 1-mm polypropylene sieve attached to a 1-L pre-cleaned borosilicate glass bottle. Following collection, the water sample was acidified to pH <2 with 6N HCl (OmniTrace, EMD Chemicals Inc., Gibbstown, New Jersey), then kept cold (about 4°C) and in the dark during storage and transport to analytical facilities at CERC. Each water sample for TSS was poured through a 1-mm polypropylene sieve attached to a pre-cleaned wide-mouth 1-L Nalgene polypropylene bottle. The TSS samples were refrigerated (about 4°C) during storage, and chilled on blue ice while being transported to CERC.

Filtered Water

Water for selenium speciation was filtered by using a battery-powered peristaltic Geotech Geopump Series 1 (Geotech Environmental Equipment, Inc., Denver, Colorado) that was equipped with a standard pumphead and high-capacity 0.45-µm Geotech dispos-a-filter™ capsule. All tubing coming into sample contact was acid-cleaned silicone; a new length was used at each site and for the blank. At each site, 1 L of deionized water was filtered through the filter capsule, followed by site water. The first 200 mL of eluant was discarded, then 1 L of eluant was collected in an acid-cleaned 1-L borosilicate glass bottle and acidified to pH <2 with 6N HCl (OmniTrace, EMD Chemicals). The acidified sample was stored and transported to CERC as described above for unfiltered water.

Waterborne Particulates

A polycarbonate Geotech 142-mm plate filter apparatus was used with a 142-mm 0.4-µm polycarbonate filter to collect waterborne particulate matter for selenium determinations. At each site, 0.5 L of deionized water was filtered through the plate filter, followed by up to 1 L of site water. After recording its volume, the filtered water was discarded. Each filter was placed in a pre-cleaned plastic petri dish (150 × 15 mm) with particulate side up, and sealed with its corresponding cover for freezer storage and eventual transport to CERC. After sampling was completed at each site, the plate filtration unit was rinsed with 0.1 percent nitric acid, followed by thorough rinsing with deionized water.

Sediment

Sediment samples were collected from all 29 drains and ponds in April, and from the seven intensively monitored drains in October for measurement of temperature, redox potential, pH, particle size distribution, TOC, and total selenium. Sediment was collected from a depth of 2–6 cm with a stainless steel dredge from five collection points along each drain. After collecting a sample, the dredge was cleared of mud and rinsed with site water. Prior to collecting a sample from a new site, the dredge was rinsed with deionized water and with water from the new site. *In-situ* measurements of temperature, redox potential, and pH were made by inserting glass electrodes directly into each sample prior to removal from the dredge. After combining equal volumes (0.24 L each) of sediment from the five collection points to form a single, well-mixed composite sample, aliquots of the composite were placed into a 0.47-L and a 0.12-L polypropylene container (Nalgene®). The 0.47-L sample was used for analysis of particle size distribution and TOC, whereas the 0.12-L sample was used for total selenium determinations. (Note: The particle size categories of sediment samples were roughly equivalent to the following pore diameters: clay, less than 0.002 mm; silt, 0.002–0.05 mm; sand, 0.05–2.0 mm; and gravel, greater than 2.0 mm; see Foth and others, 1982.) Both sample containers were retained on blue ice until returning from the field, then refrigerated (about 4°C) for storage and shipment to CERC.

Filamentous Algae

Filamentous algae was collected from floating mats and submerged sticks and rocks, and temporarily held in a plastic Tupperware®-type container on blue ice. After returning from the field, the material was rinsed with deionized water, wrapped with plastic wrap, stored in a plastic Ziploc® bag, and then frozen for storage and transport to CERC.

Net Plankton

Plankton was collected either by repeatedly casting and retrieving a student plankton net (constructed with Nitex® bolting cloth, which has a mesh size of 80 µm; catalog no. 6JB-223527, Ben Meadows Company, Janesville, Wisconsin), or by using the netting material to strain the flow from a portable sump pump immersed several centimeters below the water surface in a drain. After removing excess site water, each sample was rinsed three times with deionized water, and then the plankton and any remaining rinse water were flushed into a 0.12-L Nalgene® polypropylene container. The plankton samples were temporarily stored on blue ice, then immediately frozen upon return from the field. Subsequently, the frozen samples were transported to CERC for total selenium determinations.

Midge Larvae and Particulate Organic Detritus

Insect sweep nets were used to collect sediment and other bottom substrate materials containing a mix of benthic macroinvertebrates and particulate organic detritus, and then site water and a polypropylene sieve were used to rinse away most extraneous mud and clay. Midge larvae and large pieces of detritus were hand-picked with plastic tweezers from the sieve and temporarily held in plastic Tupperware®-type containers on blue ice. After returning from the field, the samples were rinsed with deionized water, wrapped in plastic wrap, then stored in plastic Ziploc® bags, and frozen. The frozen samples were subsequently transported to CERC.

Fish

Fish were captured with unbaited minnow traps, dip nets, and a small seine, sorted according to species (western mosquitofish and sailfin mollies were retained), and temporarily held in plastic Tupperware®-type containers on blue ice. After returning from the field, individuals of each species were measured for total length, weighed, and rinsed with deionized water. As many as 20 fish of each species were wrapped in plastic wrap and placed into a plastic Ziploc® bag, then frozen. The frozen samples were subsequently transported to CERC.

Quality Control for Selenium and Other Chemical Determinations

The quality control results for analytical determinations of samples collected during April, July, and October 2007, and January 2008 are reported by May and others (2007b, 2008). According to May and others (2007b, 2008), all results were within acceptable limits as specified by CERC.

Data Management and Statistical Analysis

Raw data are stored as Microsoft® Excel files on a desktop PC and summarized with SAS version 9.1 (SAS Institute Inc., Cary, North Carolina) or other appropriate statistical and graphical software. Unless specified otherwise, the level of significance for rejecting null hypotheses of statistical tests is $P \leq 0.05$.

Results and Other Progress

Water Quality

During the four sampling events between April 2007 and January 2008, the 29 drains and ponds collectively exhibited the following water quality conditions (values are geometric means and ranges): temperature, 19.20°C (range, 9.09–31.26°C); dissolved oxygen, 6.35 mg/L (range, 0.15–14.78 mg/L); pH, 7.78 (range, 6.14–8.79); specific conductance, 3.34 mS/cm at 25°C (range, 1.16–18.48 mS/cm at 25°C); turbidity, 6.1 NTUs (0.0–728.0 NTUs); total suspended solids, 69.3 mg/L (range, 2.40–780.0 mg/L); and total selenium from unfiltered samples, 4.38 µg/L (range, 0.790–64.5 µg/L) (figs. 2–8; see appendix table A1 for raw data). In addition, water depth at fixed sampling sites averaged 24 cm (range, 3–86 cm).

Judging from Spearman rank correlation coefficients, direct associations existed between specific conductance and selenium, turbidity and total suspended solids, and dissolved oxygen and pH. By comparison, inverse associations existed between temperature and dissolved oxygen, pH and selenium, specific conductance and turbidity, and specific conductance and total suspended solids (table 2). Although not statistically significant ($0.05>P>0.0024$) when the Bonferroni correction factor was used to accommodate 21 simultaneous comparisons, weak inverse associations also existed between dissolved oxygen and total suspended solids, and turbidity and selenium.

When water quality data from all 29 drains and ponds were considered together, evidence of temporal variation was found for temperature, dissolved oxygen, and pH, but not for specific conductance, turbidity, total suspended solids, and total selenium (table 3). Temperature was highest in July, intermediate in April and October, and lowest in January. By comparison, dissolved oxygen concentration was highest in January, followed by April, then by October, and lowest in July. Hydrogen-ion concentrations (pH) were highest in October, and lower in January, April, and July (mean values were not significantly different during these 3 months).

Although several water quality variables exhibited significant spatial variations over the 29 drains and ponds (pH, $F=5.23$, $P<0.0001$; specific conductance, $F=6.45$, $P<0.0001$; turbidity, $F=2.35$, $P=0.0014$; total suspended solids, $F=5.00$, $P<0.0001$; total selenium, $F=13.91$, $P<0.0001$; in all instances, df1=28 and df2=87), no consistent patterns were observed (see figs. 2–8).

According to Ward's minimum-variance method of cluster analysis with mean concentrations of total selenium, the 29 drains and ponds can be segregated into at least two major clusters (groups): one composed of three high-Se drains (Q Drain, 17.1 µg Se/L; Trifolium 18 Drain, 21.8 µg Se/L; and Trifolium Storm Drain, 34.0 µg Se/L), and a second composed of the remaining 26 drains or ponds containing much lower selenium concentrations (1.10–7.46 µg Se/L; see fig. 9). The existence of two clusters is suggested by a plot of semipartial R^2 values, where the number of significant clusters corresponds to the greatest reduction in those values (fig. 10).

Sediment Quality

Measurements of sediment quality were obtained from all 29 drains and ponds in April, but only from seven drains in October. Sediment temperatures ranged from 12.85 to 27.18°C (mean, 19.43°C), sediment redox potential ranged from -417.8 to 58.52 mV (mean, -232.41 mV), and sediment pH ranged from 6.86 to 7.57 (mean, 7.15), with no discernible spatial or temporal patterns (figs. 11-13; see appendix table A2 for raw data). Although considerable variation was encountered, a combination of sand, silt, and clay typically characterized sediment samples (fig. 14; see appendix table A3 for raw data). Total organic carbon also varied widely, with the highest values (•3 percent) occurring in samples from Trifolium 23 Drain, Trifolium 13 Drain, Vail 5 Pond, Lack & Lindsey Pond, and Niland 4 Drain (fig. 15; see appendix table A2 for raw data). On 5 of 7 instances, TOC was higher in samples collected in April than in October. Selenium concentrations in sediment samples are reported later in this report (see section, "Selenium Concentrations in Water, Sediment, Aquatic Food Chain Matrices, and Surrogate Fish Species").

Fish Species Composition and Abundance

All 29 drains and ponds were fished with baited minnow traps in April and October 2007, and in January 2008. Fish were not sampled in July 2007 because we lacked approval from the California Department of Fish and Game for incidental take of desert pupfish from the study area.

A total of 6,253 fish representing 8 species was captured by minnow traps during the three sampling periods (fig. 16; see appendix table A4 for raw counts of fish). The most numerous species was western mosquitofish (N=5,261), followed by red shiner (*Cyprinella lutrensis*, N=423), sailfin molly (N=282), desert pupfish (N=182), hybrid Mozambique tilapia (*Oreochromis mossambicus* x *O. urolepis*, N=98), bluegill (*Lepomis macrochirus*, N=5), and lastly by redbelly tilapia (*Tilapia zilli*, N=1) and common carp (*Cyprinus carpio*, N=1). Although not documented in minnow trap catches, several largemouth bass (*Micropterus salmoides*) fry were caught during supplemental sampling with a seine in the T Drain during April 2007.

The total numbers of fish captured in minnow traps ranged from 0 at Trifolium 22 Drain and S Drain, to 4,412 at Trifolium 19 Drain (fig. 16). Desert pupfish were most numerous at Trifolium 14 Drain (N=135), followed by Former Trifolium 20 Drain (N=43), and then by Trifolium 18 Drain, Trifolium 13 Drain, Lack & Lindsey Pond, and Pumice Pond (N=1 for each of these drains or ponds). The remaining 23 drains and ponds failed to yield pupfish.

Most fish were caught during October (N=4,685), followed by January (N=1,322), then by April (N=246). However, most desert pupfish were caught in October (N=134), followed by April (N=46), then by January (N=2).

Although abundance of several fish species was weakly associated (P•0.05) with one or more water quality variables (for example, western mosquitofish and temperature, r_s =0.32, P=0.0022; sailfin molly and temperature, r_s=0.27, P=0.0115; hybrid Mozambique tilapia and temperature, r_s =0.28, P=0.0079; sailfin molly and pH, r_s=0.23, P=0.0316; and red shiner and total suspended solids, r_s =0.24, P=0.0270), none of these correlations were significant according to the adjusted Bonferroni P=0.0009 for 56 simultaneous comparisons. No relation was found between abundance of desert pupfish and water quality variables, including total selenium concentrations.

Selenium Concentrations in Water, Sediment, Aquatic Food Chain Matrices, and Surrogate Fish Species

Samples of water, sediment, aquatic food chain matrices (particulate organic detritus, filamentous algae, net plankton, and midge larvae), and surrogate fish species (western mosquitofish and sailfin molly) were collected for selenium determinations during intensive monitoring of seven drains (Trifolium 20, Poe, Trifolium 18, Trifolium 14, O, T, and Z-Spill) in April and October 2007. Overall, total selenium concentrations averaged 0.00523 µg/mL (5.23 µg/L) in unfiltered water, 0.00515 µg/mL (5.15 µg/L) in filtered water, 1.33 µg/g dry weight in sediment, 5.27 µg/g dry weight in particulate organic detritus, 2.27 µg/g dry weight in filamentous algae, 2.31 µg/g dry weight in net plankton, 5.13 µg/g dry weight in midge larvae, 6.06 µg/g dry weight in sailfin molly, and 6.43 µg/g dry weight in western mosquitofish (values are weighted geometric means from the combined 2 months; see table 4). Hereinafter, except for water, all selenium measurements are reported on a dry-weight basis.

Water

The mean concentrations of various forms of selenium in unfiltered water samples (N=28) were: selenite (SeO_3^{-2}), 0.478 µg/L; selenate (SeO_4^{-2}), 4.03 µg/L; dissolved organic selenium, 0.359 µg/L; and particulate selenium, 0.054 µg/L. Thus, nearly 99 percent of selenium in unfiltered water samples consisted of dissolved species, with selenate accounting for the largest proportion. This general pattern was observed at all seven intensively monitored drains during April and October (fig. 17; see appendix table A5 for raw data).

Dissolved selenium concentrations varied widely among drains (0.700–24.1 µg/L), with lowest concentrations occurring in T Drain during both April and October, and highest concentrations occurring in Trifolium 18 Drain during April and in Trifolium 14 Drain during October (table 5). Some temporal variations also were detected, but consistent patterns were not observed. From April to October, dissolved selenium concentrations increased at Trifolium 14 Drain, O Drain, and Z Spill Drain, but decreased at Trifolium 20 Drain, Poe Drain, and Trifolium 18 Drain. Although the mean concentration of dissolved selenium decreased slightly from April to October at T Drain, the difference was not statistically significant.

Sediment

Selenium concentrations in sediments ranged from 0.15 µg/g at Former Trifolium 20 Drain in April to 7.28 µg/g at Trifolium 18 Drain in October (table 6, fig. 18; see appendix table A2 for raw data). Sediments in 12 drains contained less than 1.0 µg Se/g, whereas sediments in two drains (Trifolium 18 Drain, Vail 5 Drain) contained more than 5.0 µg Se/g. Although lack of sample replication (N=1 for each sampling date and drain) prevented statistical inference, selenium concentrations differed by less than two-fold between April and October at the seven intensively monitored drains. Selenium concentrations were significantly correlated with silt, TOC, and redox potential, but not with other sediment particle size fractions, temperature, or pH (table 7).

Food Chain Organisms

Selenium concentrations in samples of particulate organic detritus, filamentous algae, net plankton, and midge larvae typically were highest at Trifolium 18 Drain, although high concentrations occasionally were measured in some matrices from Poe Drain, Trifolium 14 Drain, and elsewhere (tables 8-11; see appendix table A6 for raw data). Significant temporal differences in selenium concentrations also were documented in some matrices, but a consistent pattern was not observed. In general, selenium concentrations in food-chain matrices from Trifolium 18 Drain were roughly equivalent to concentrations reported in similar matrices from seleniferous surface waters in the Grassland Water District (for example, North Mud Slough), San Joaquin Valley, California (Saiki and others, 1993).

Surrogate Fish Species

Highest concentrations of selenium generally occurred in samples of sailfin molly and western mosquitofish collected from Trifolium 18 Drain (tables 12-13; see appendix table A7 for raw data). Temporal variations were present in mosquitofish and molly from several drains, but the patterns were not consistent. Mosquitofish from Trifolium 18 Drain exhibited selenium body burdens of 13.2–20.2 µg/g. By comparison, mosquitofish from North Mud Slough, a tributary of the San Joaquin River that is excessively contaminated with seleniferous subsurface agricultural drainwater, averaged 11–16 µg Se/g (Saiki and others, 1993). According to studies summarized by Lemly (2002), fish can experience tissue damage in major organs, reproductive impairment, and mortality when whole-body selenium concentrations reach 16–19 µg/g.

General Patterns of Selenium Bioaccumulation

With two exceptions, selenium concentrations in water, sediment, various food-chain matrices, and surrogate fish species were not significantly correlated with one another according to an adjusted Bonferroni P=0.0018 for 28 simultaneous comparisons (table 14). The exceptions were selenium concentrations in sediment vs. filamentous algae (r_s=0.78, P=0.0010) and detritus vs. western mosquitofish (r_s=0.85, P=0.0001). Although not statistically significant, 11 comparisons exhibited weak correlations (0.05•P>0.0018): filtered water vs. sediment; filtered water vs. detritus; filtered water vs. filamentous algae; filtered water vs. western mosquitofish; sediment vs. net plankton; sediment vs. western mosquitofish; detritus vs. net plankton; detritus vs. midge larvae; filamentous algae vs. net plankton; net plankton vs. midge larvae; and sailfin molly vs. western mosquitofish. These correlations generally were consistent with the hypothesis that selenium originates in agricultural drainwater, then is bioconcentrated in algae and becomes especially enriched in detritus possibly due to microbial activity (the selenium measured in sediment may be an artifact caused by its detrital content, as suggested by a significant correlation between sediment selenium and TOC; see table 7). When primary consumers such as zooplankton and midge larvae consume algae, detritus, or both, they assimilate a portion of the selenium. Consumption of zooplankton and midges by secondary consumers such as fish also results in uptake of this element. In general, selenium concentrations did not increase in progressively higher links of the food chain (figs. 19-20).

Future Work

Unless instructed otherwise by IID, field work during Year 4 is expected to follow similar time schedules and methodologies given in this report.

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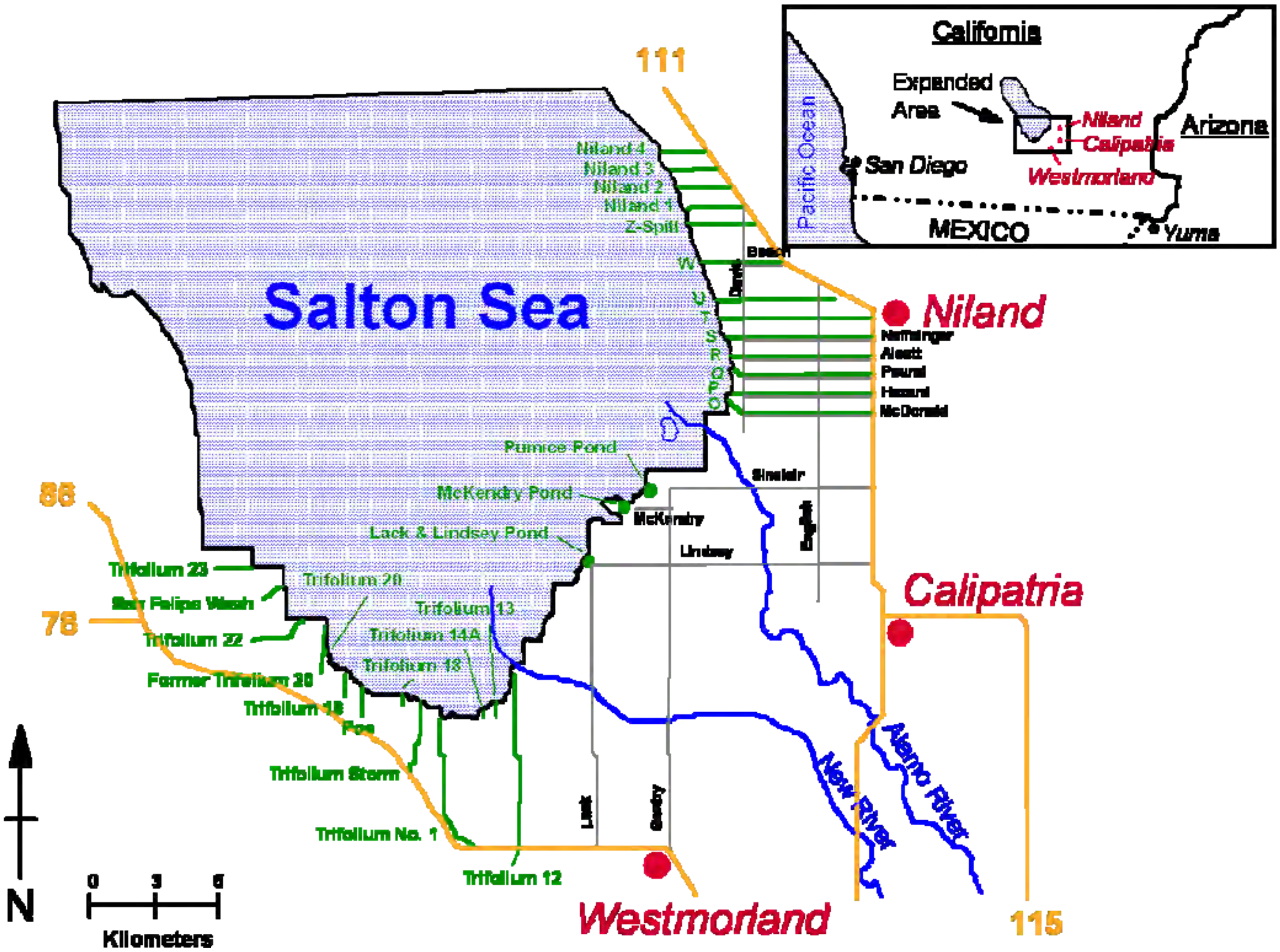

Figure 1. Map of the study area showing locations of 29 drains and ponds selected for extensive monitoring.

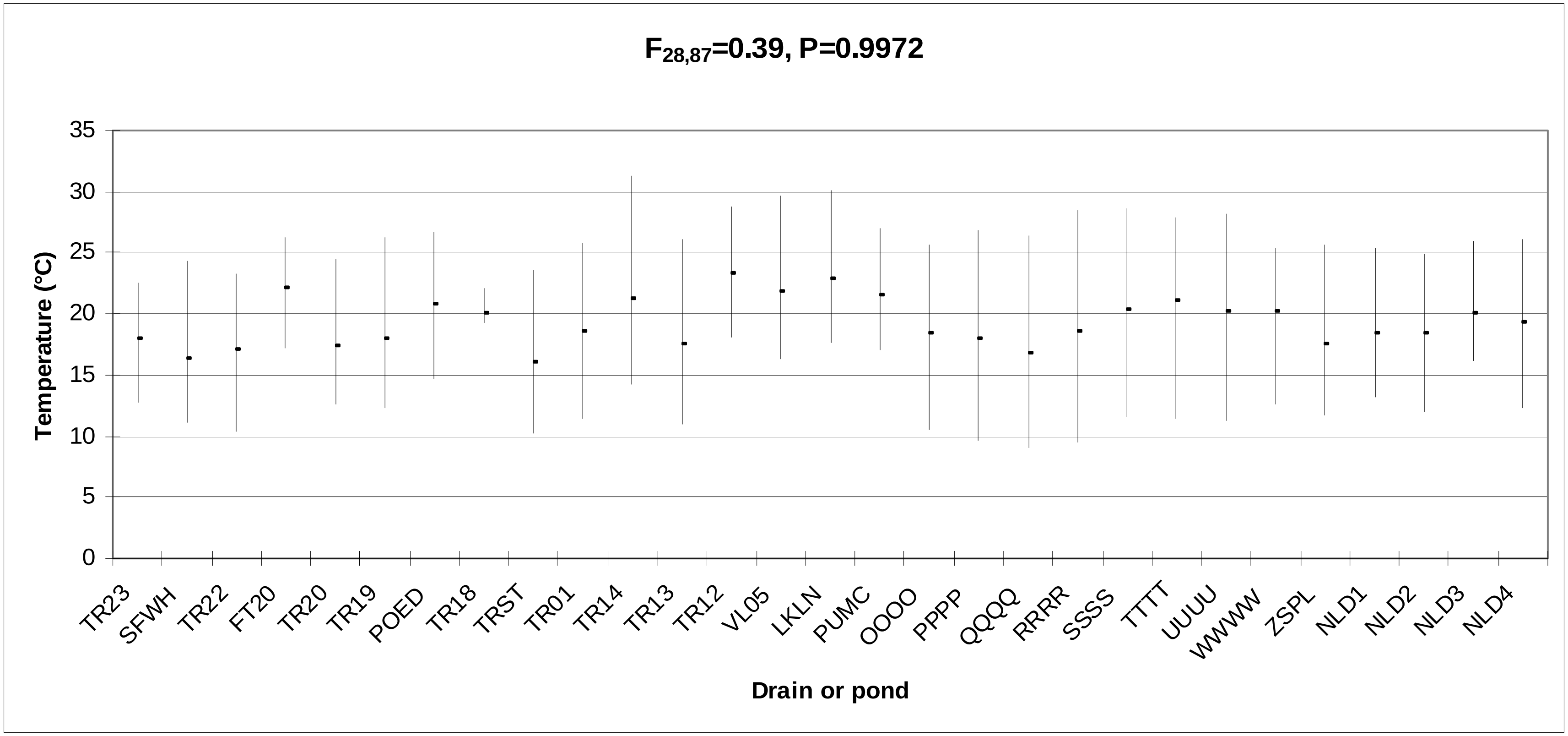

Figure 2. Water temperatures at 29 drains or ponds measured on four occasions from April 2007 to January 2008. Solid squares represent geometric means, whereas vertical lines represent minimum-maximum values. Codes for drains and ponds are given in table 1.

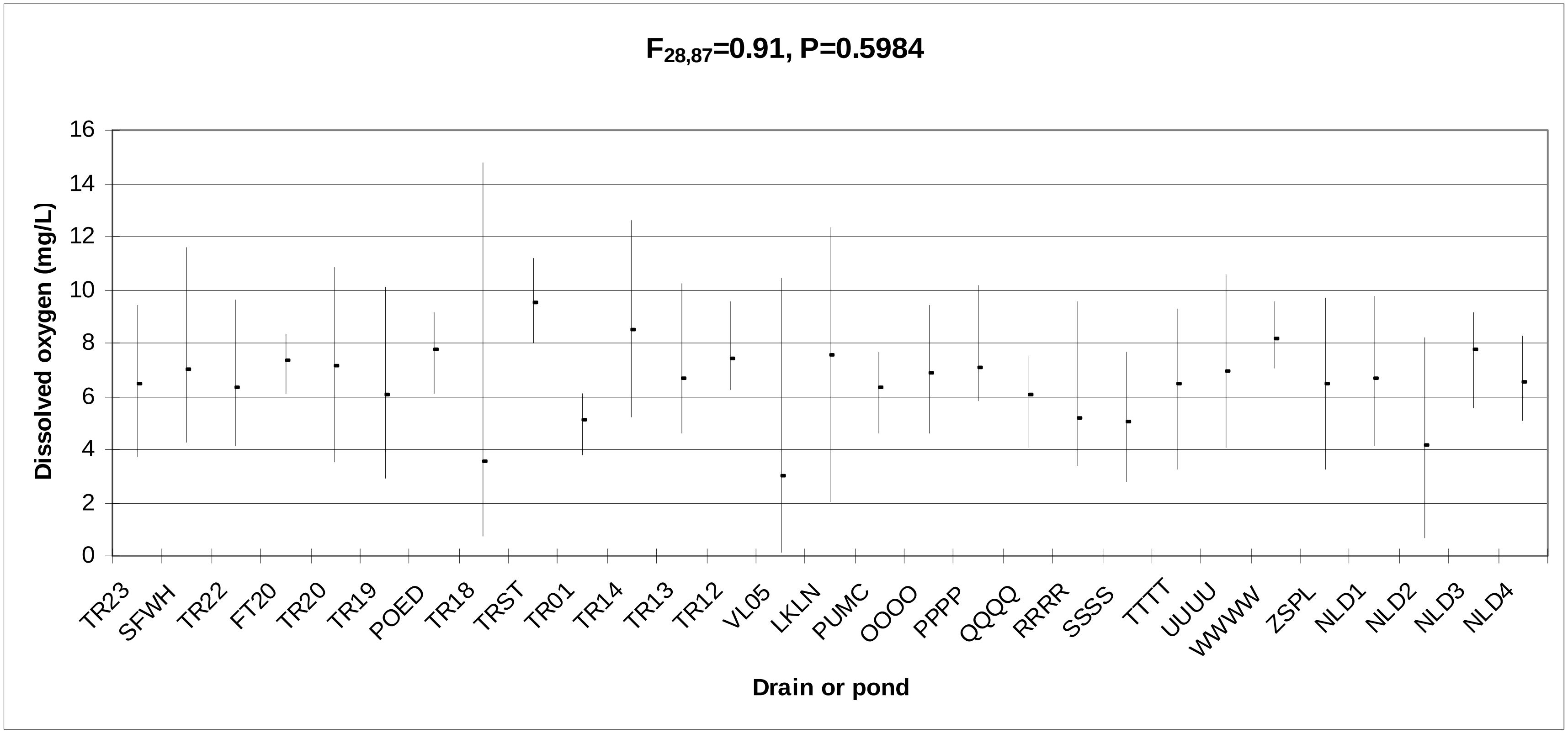

Figure 3. Dissolved oxygen concentrations at 29 drains or ponds measured on four occasions from April 2007 to January 2008. Solid squares represent geometric means, whereas vertical lines represent minimum-maximum values. Codes for drains and ponds are given in table 1.

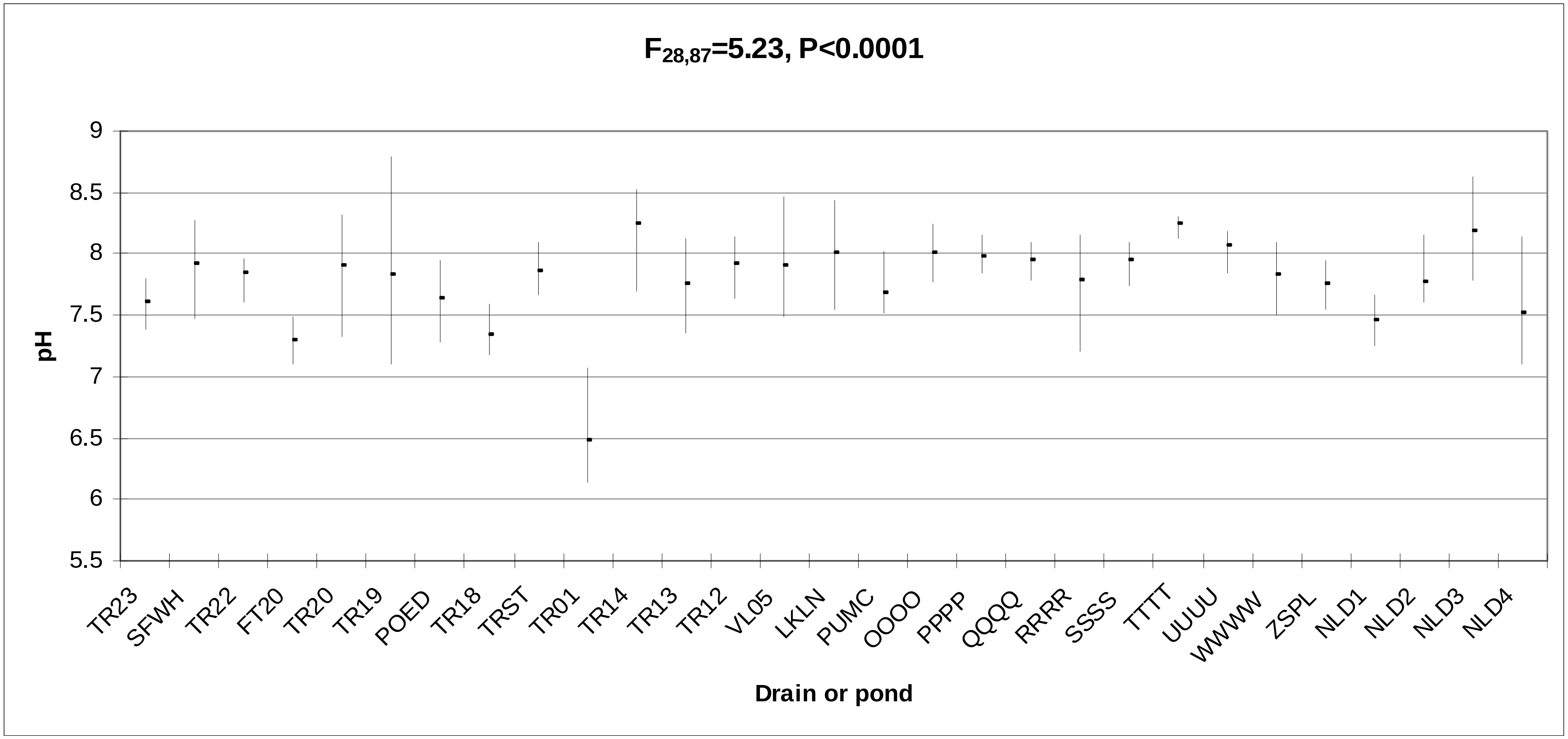

Figure 4. Hydrogen-ion concentrations (pH) at 29 drains or ponds measured on four occasions from April 2007 to January 2008. Solid squares represent geometric means, whereas vertical lines represent minimum-maximum values. Codes for drains and ponds are given in table 1.

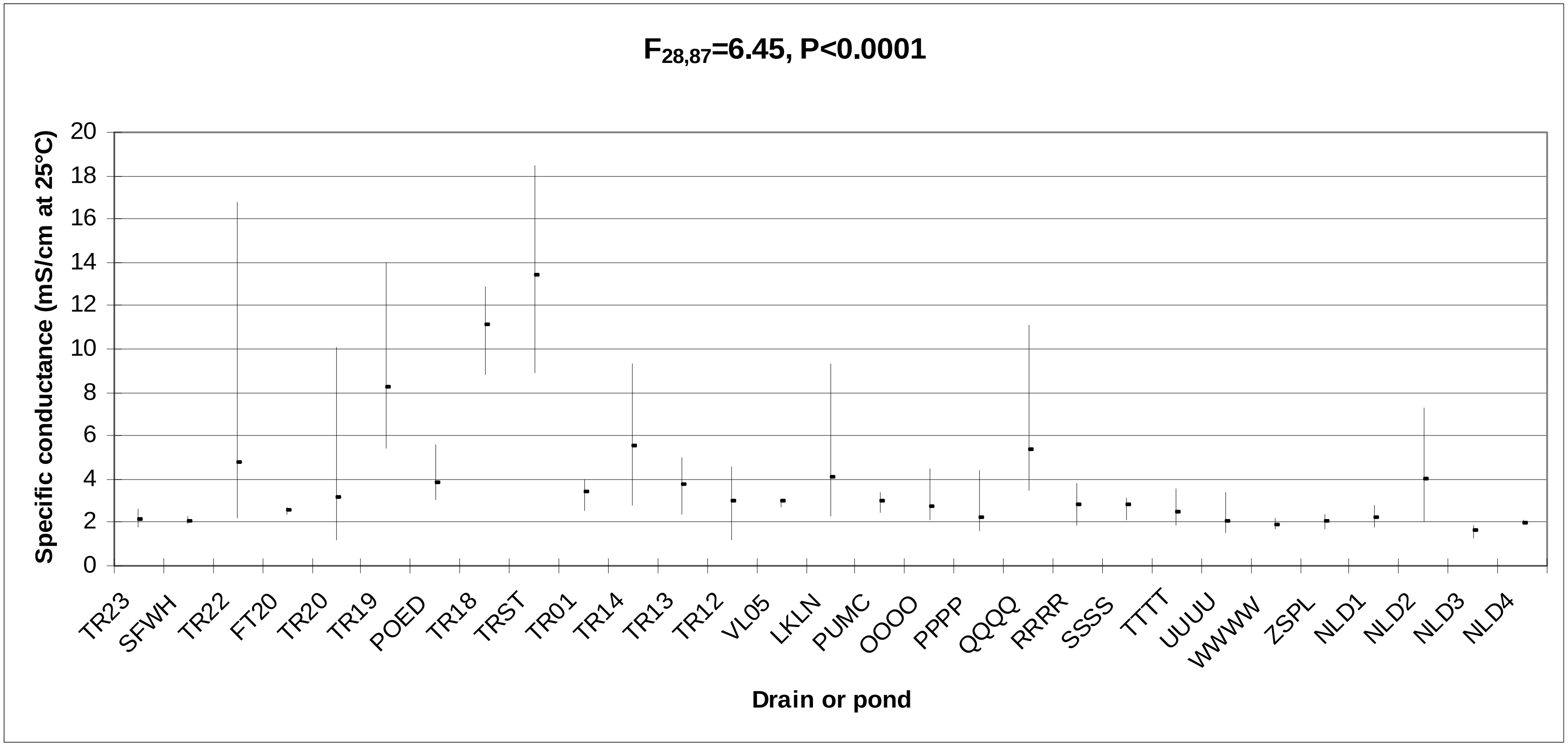

Figure 5. Specific conductance at 29 drains or ponds measured on four occasions from April 2007 to January 2008. Solid squares represent geometric means, whereas vertical lines represent minimum-maximum values. Codes for drains and ponds are given in table 1.

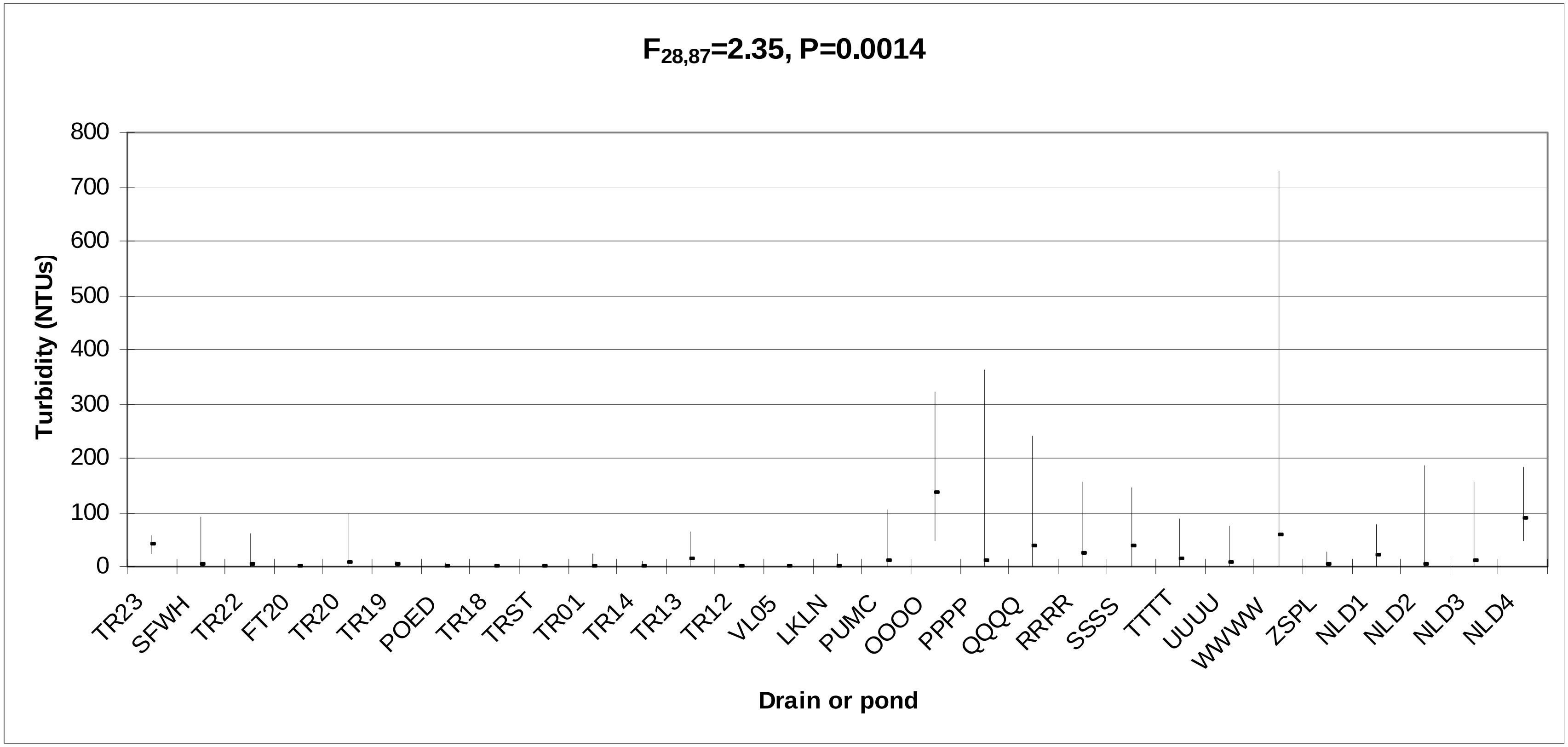

Figure 6. Turbidity at 29 drains or ponds measured on four occasions from April 2007 to January 2008. Solid squares represent geometric means, whereas vertical lines represent minimum-maximum values. Codes for drains and ponds are given in table 1.

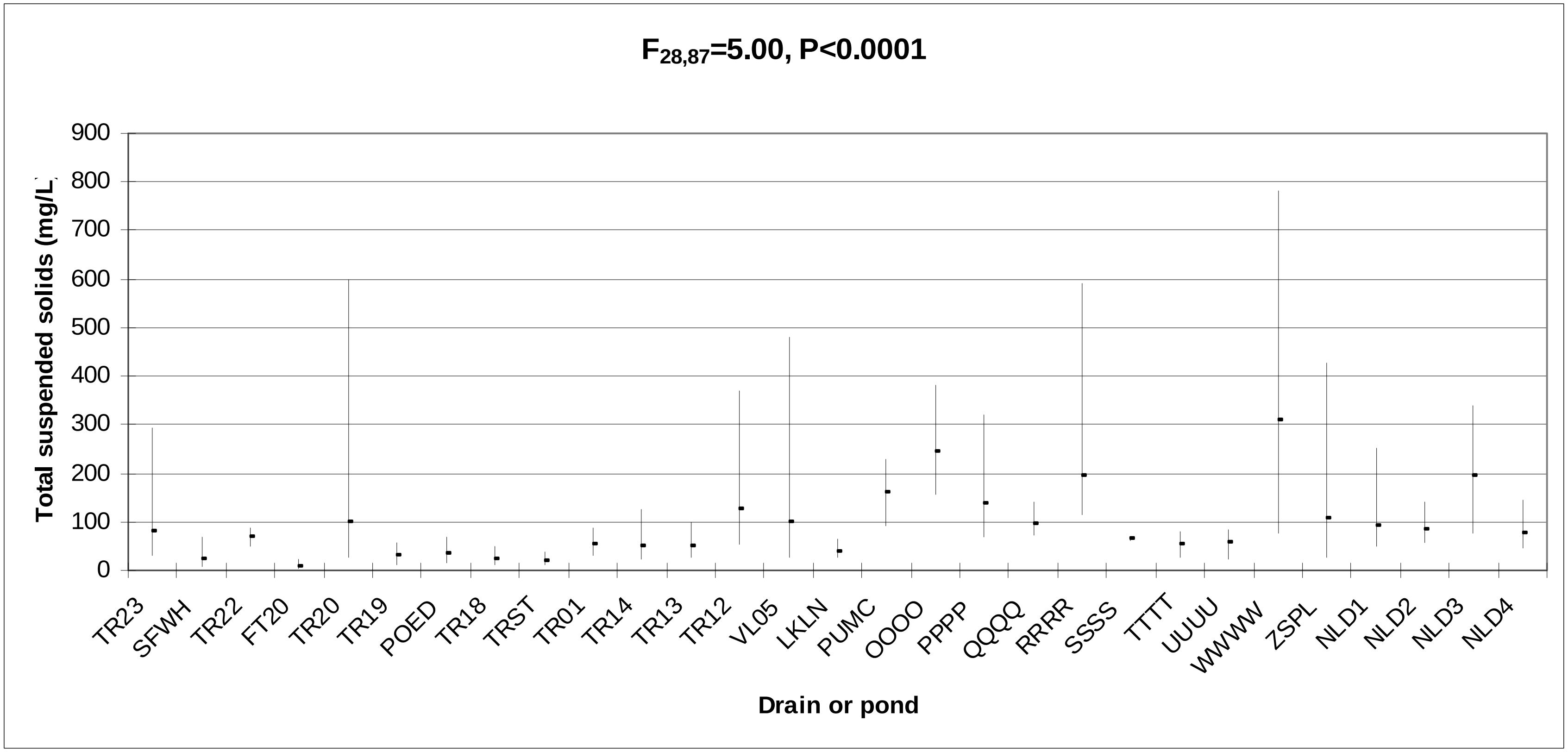

Figure 7. Total suspended solids concentrations at 29 drains or ponds measured on four occasions from April 2007 to January 2008. Solid squares represent geometric means, whereas vertical lines represent minimum-maximum values. Codes for drains and ponds are given in
table 1.

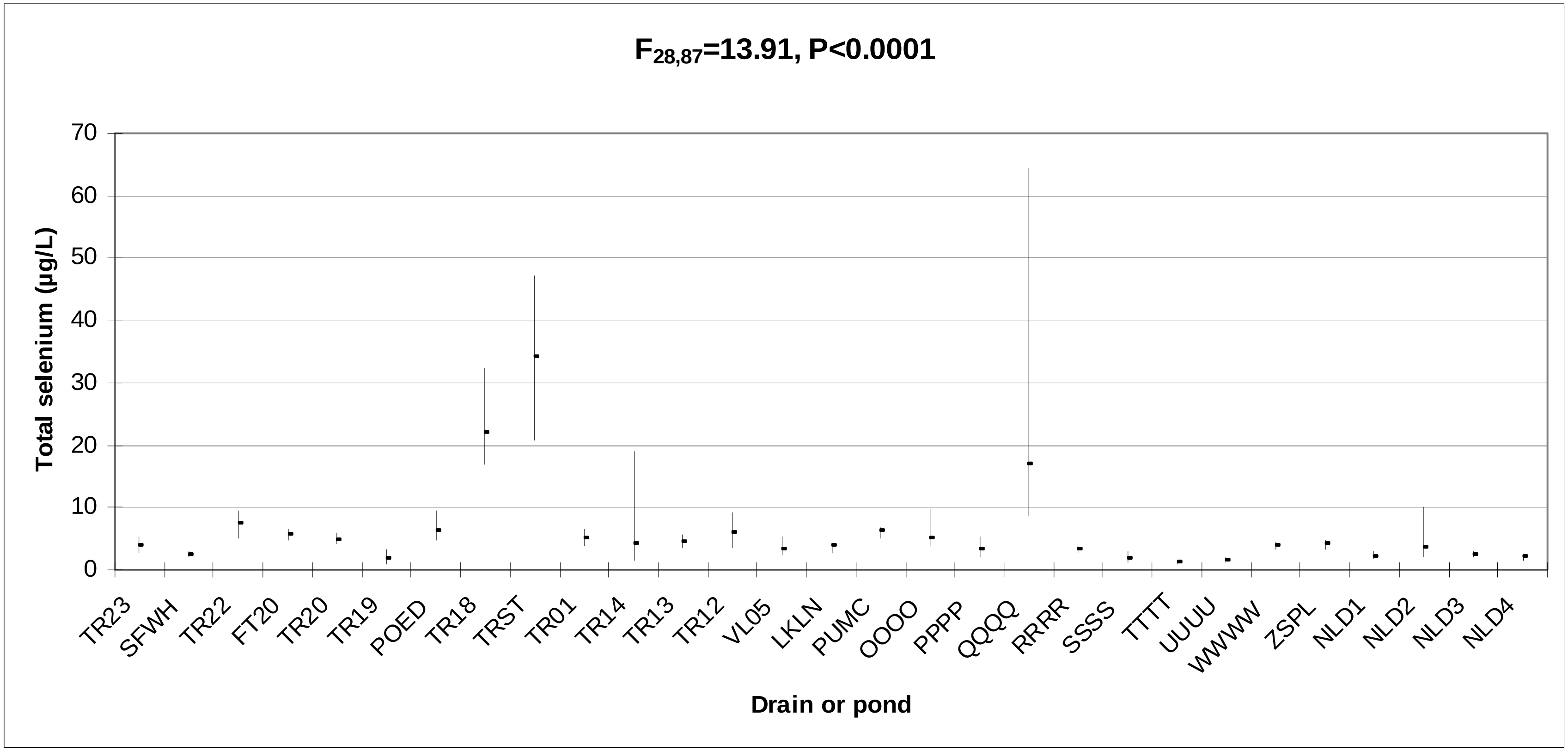

Figure 8. Total selenium concentrations at 29 drains or ponds measured on four occasions from April 2007 to January 2008. Solid squares represent geometric means, whereas vertical lines represent minimum-maximum values. Codes for drains and ponds are given in table 1.

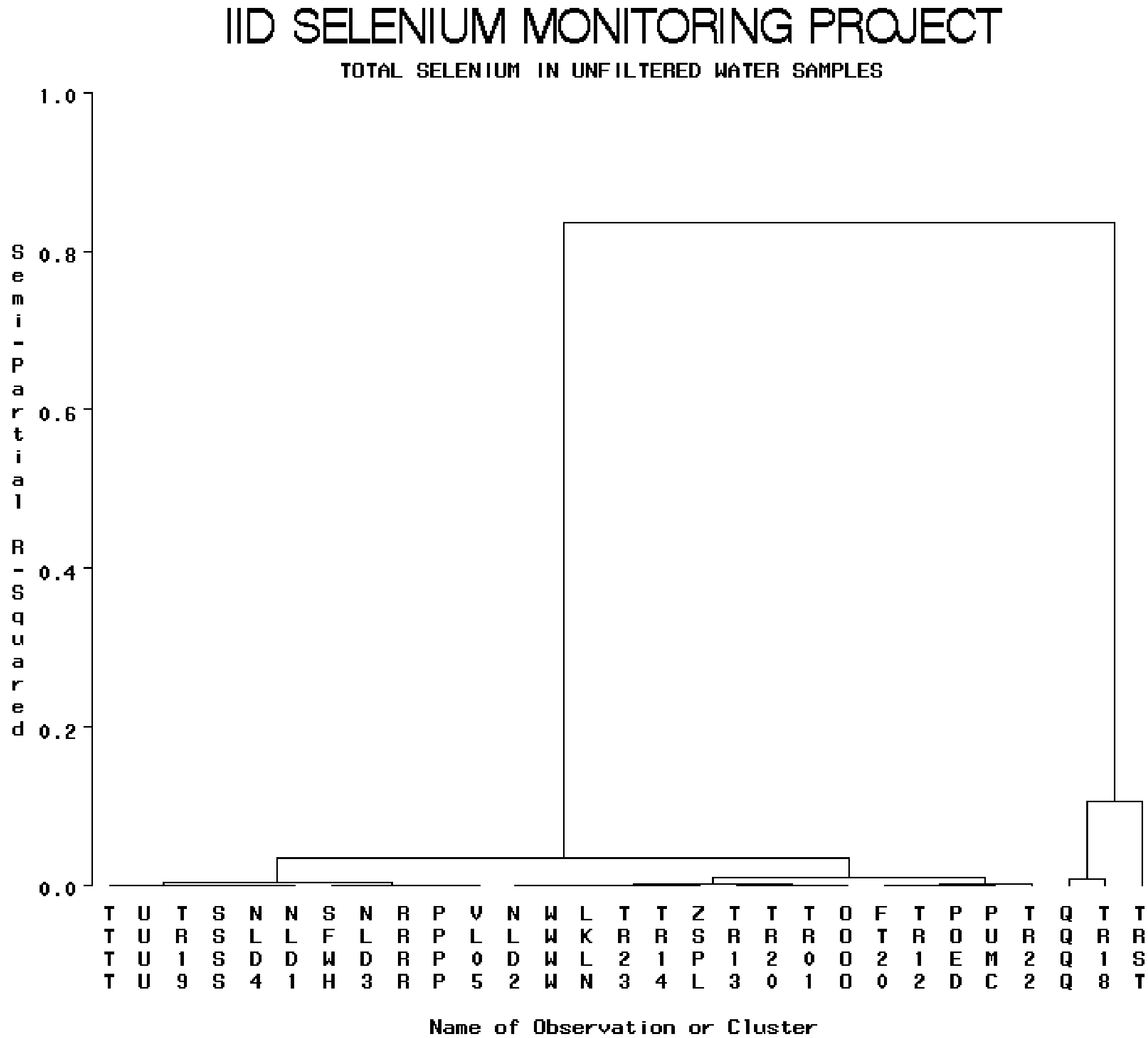

Figure 9. Dendrogram for cluster analysis (Ward's minimum-variance method) based on geometric mean values of total selenium concentrations in unfiltered water samples from 29 drains or ponds sampled on four occasions from April 2007 to January 2008. Codes for drains and ponds (X-axis) are given in table 1.

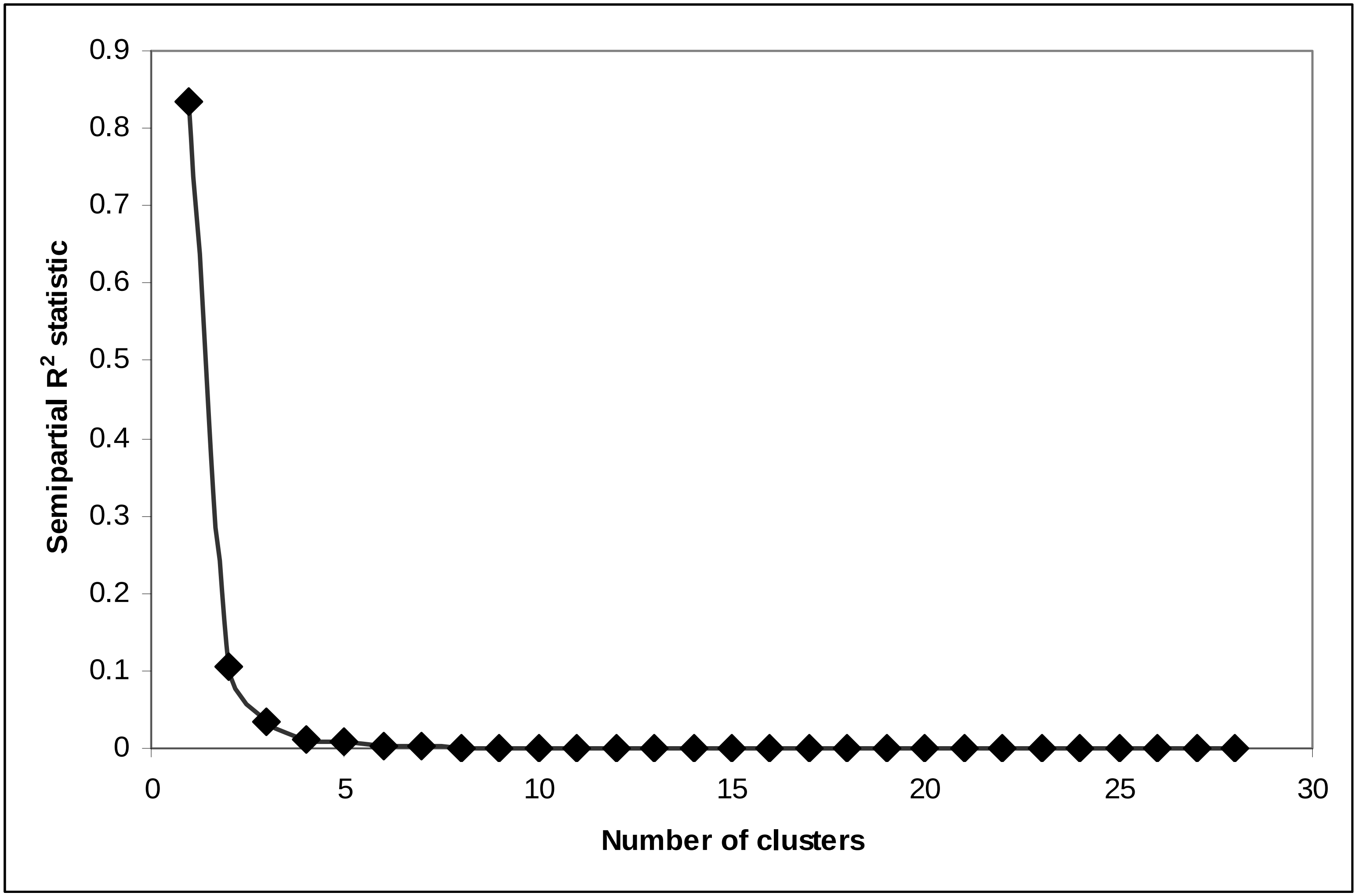

Figure 10. Relation of semipartial R^2 values to number of clusters for total selenium concentrations in unfiltered water samples. The largest reduction in semipartial R^2 values corresponds to the number of "significant" clusters which, in this study, occurred at the two-cluster level.

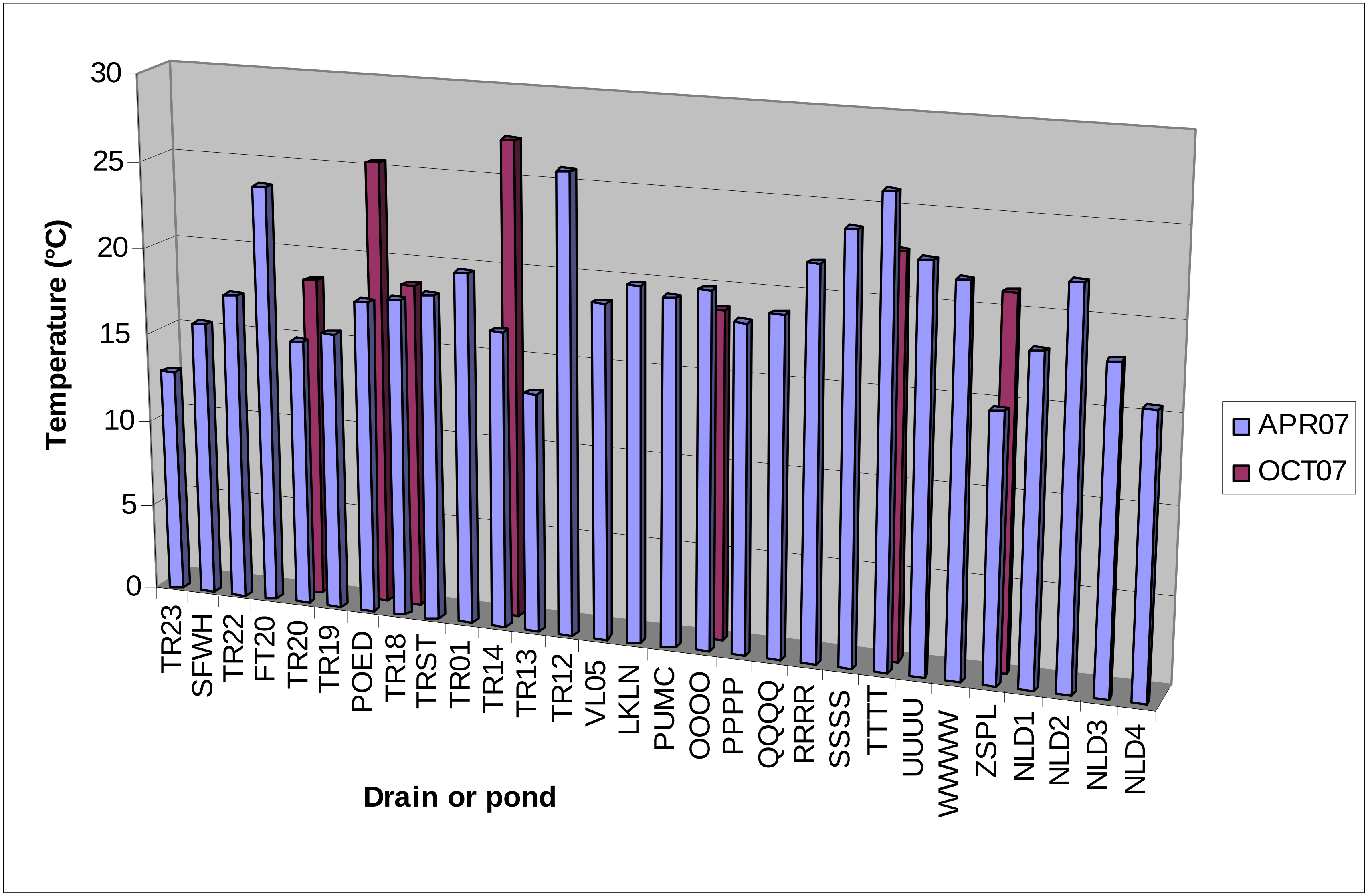

Figure 11. Temperature of sediment samples collected in April and October 2007. Twenty-nine drains or ponds were sampled in April, whereas only seven drains were sampled in October. Codes for drains or ponds are given in table 1.

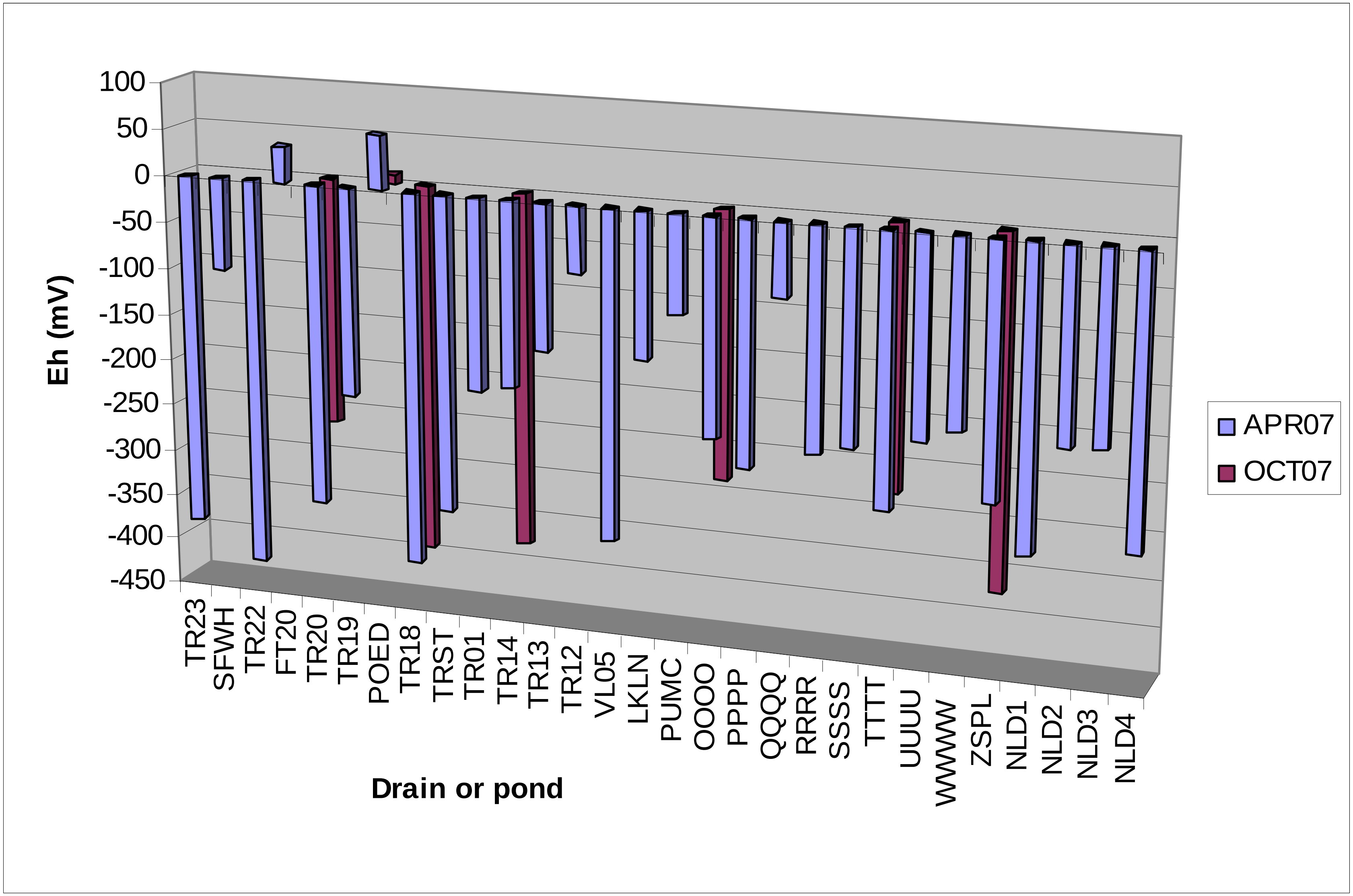

Figure 12. Redox potential (Eh) of sediment samples collected in April and October 2007. Twenty-nine drains or ponds were sampled in April, whereas only seven drains were sampled in October. Codes for drains or ponds are given in table 1.

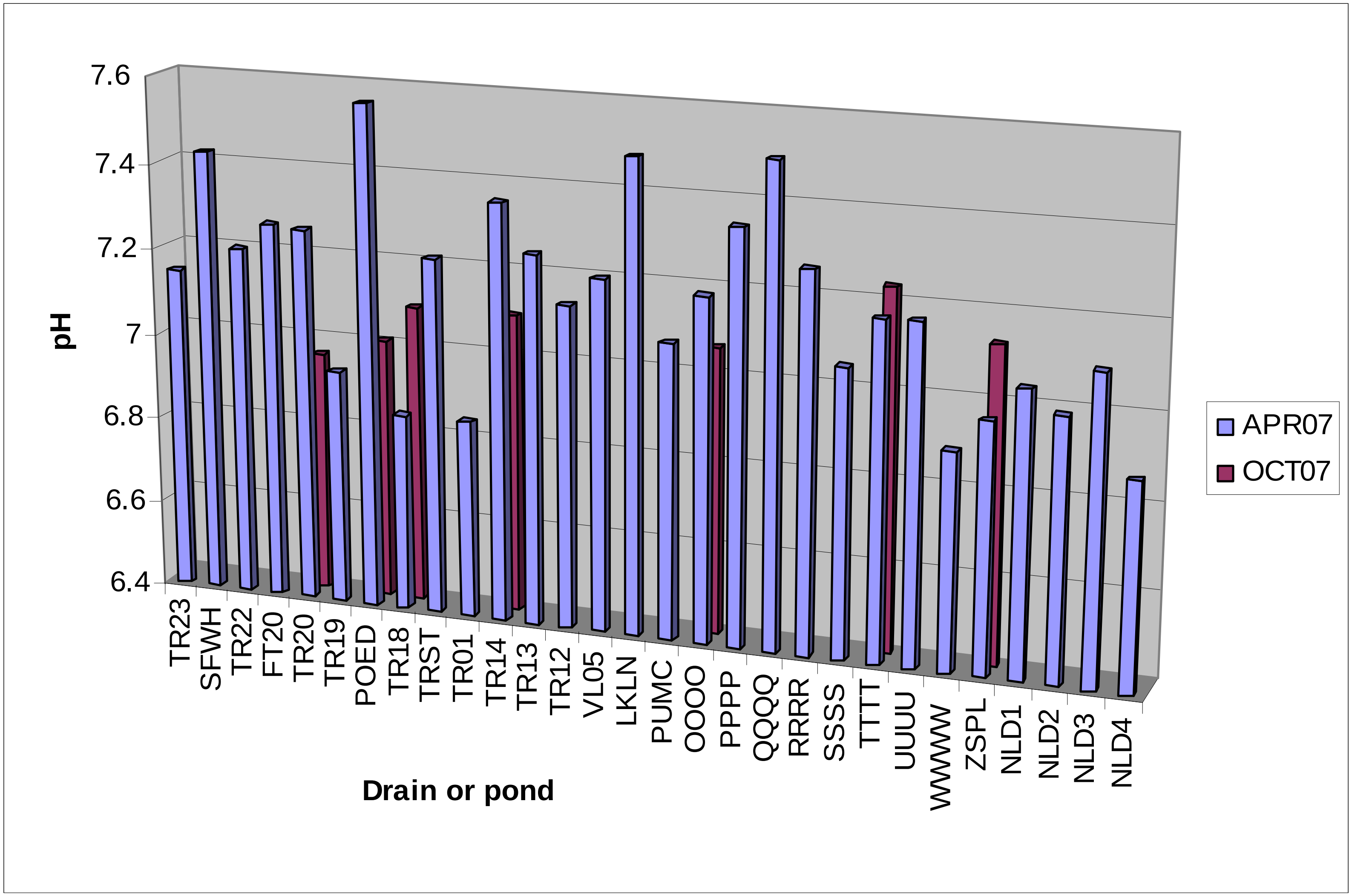

Figure 13. Hydrogen-ion concentrations (pH) in sediment samples collected in April and October 2007. Twenty-nine drains or ponds were sampled in April, whereas only seven drains were sampled in October. Codes for drains or ponds are given in table 1.

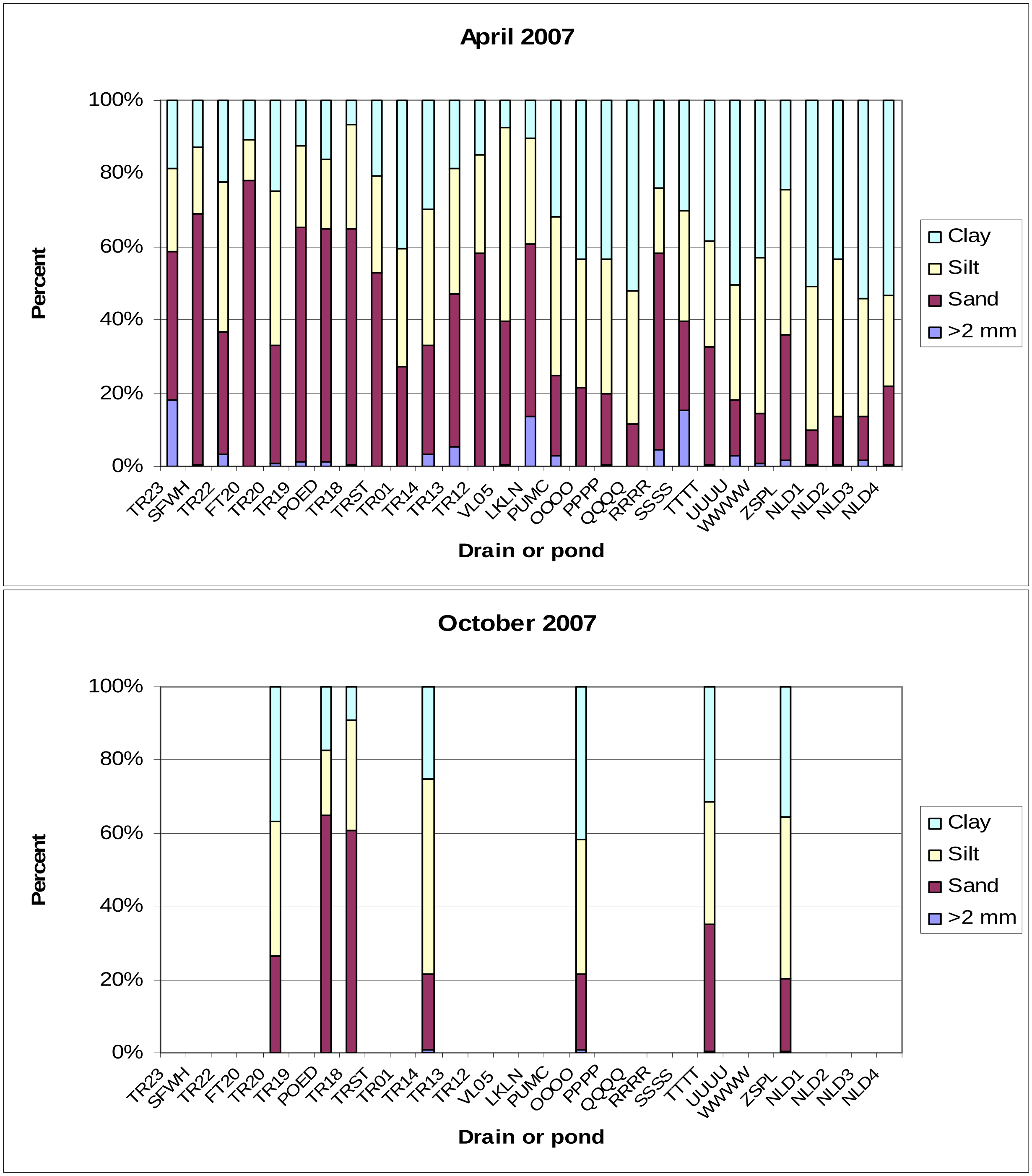

Figure 14. Particle size distribution of sediment samples collected in April and October 2007. Twenty-nine drains or ponds were sampled in April, whereas only seven drains were sampled in October. Codes for drains or ponds are given in table 1.

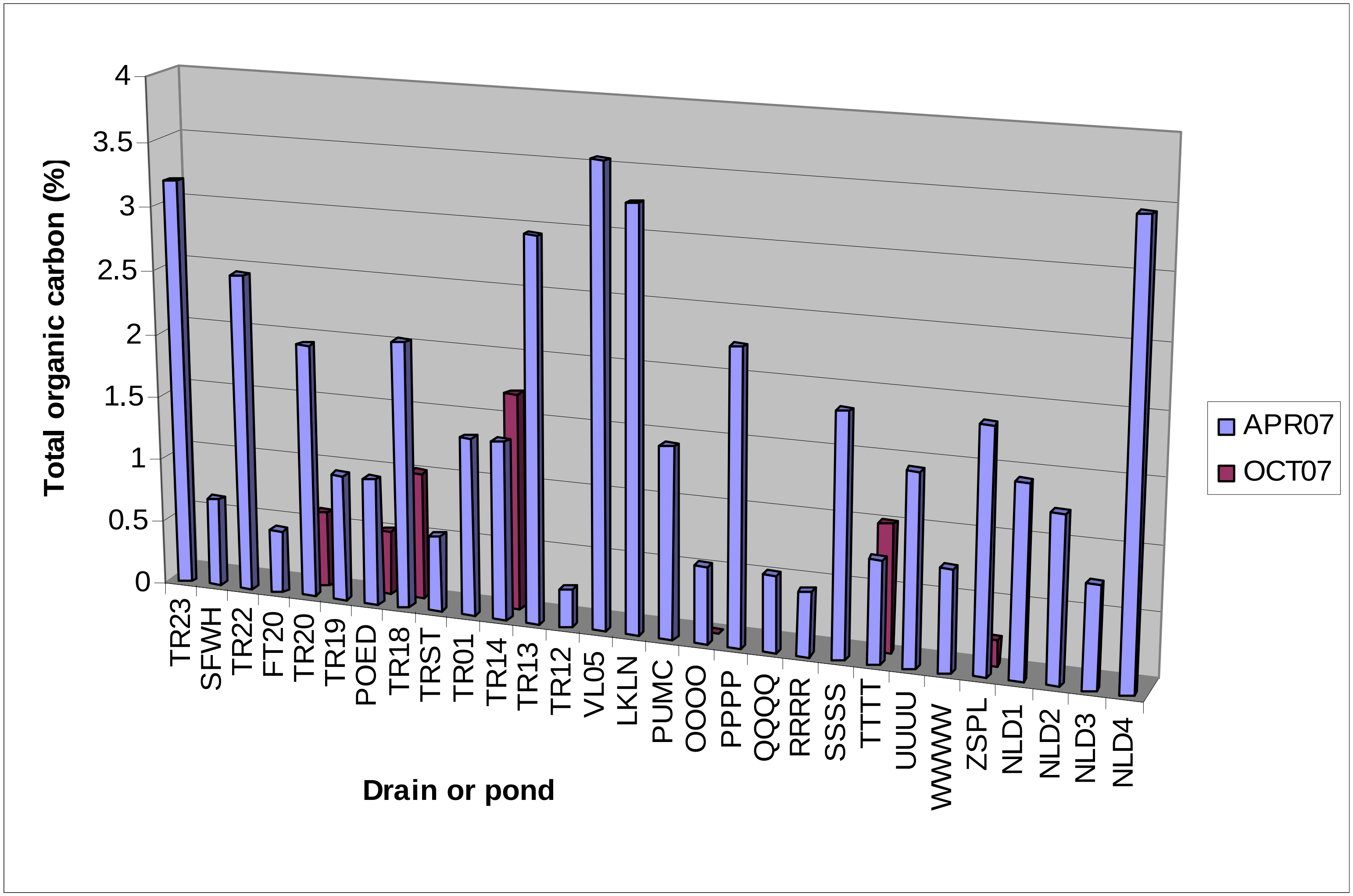

Figure 15. Total organic carbon content of sediment samples collected in April and October 2007. Twenty-nine drains or ponds were sampled in April, whereas only seven drains were sampled in October. Codes for drains or ponds are given in table 1.

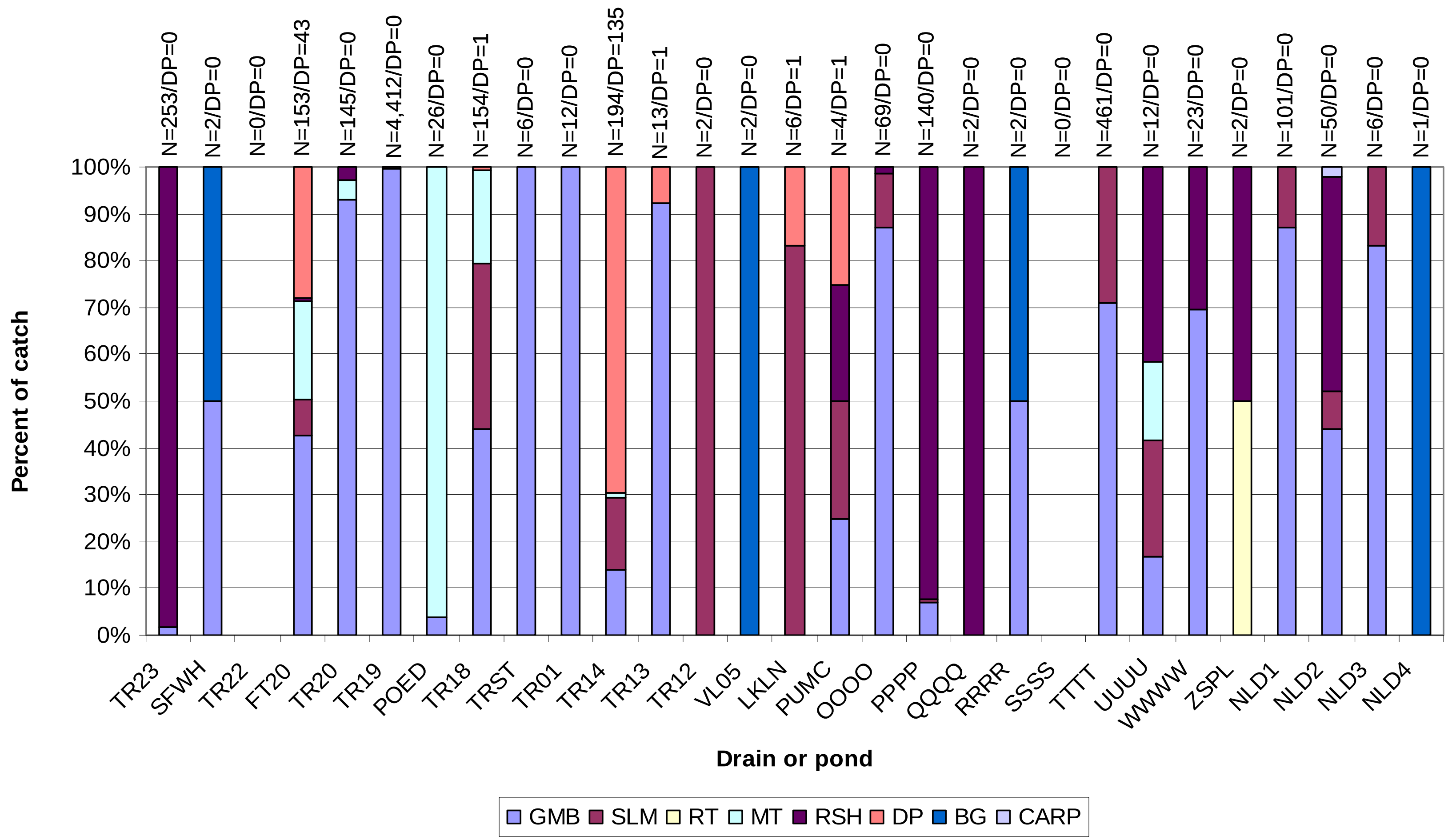

Figure 16. Relative contribution of western mosquitofish (GMB), sailfin molly (SLM), redbelly tilapia (RT), hybrid Mozambique tilapia (MT), red shiner (RSH), desert pupfish (DP), bluegill (BG), and common carp (CP) to the total catch from minnow traps fished at 29 drains or ponds during April and October 2007, and January 2008. Values above each bar indicate total numbers of fish caught (all species combined) and numbers of desert pupfish caught in each drain or pond. Codes for drains or ponds are given in table 1.

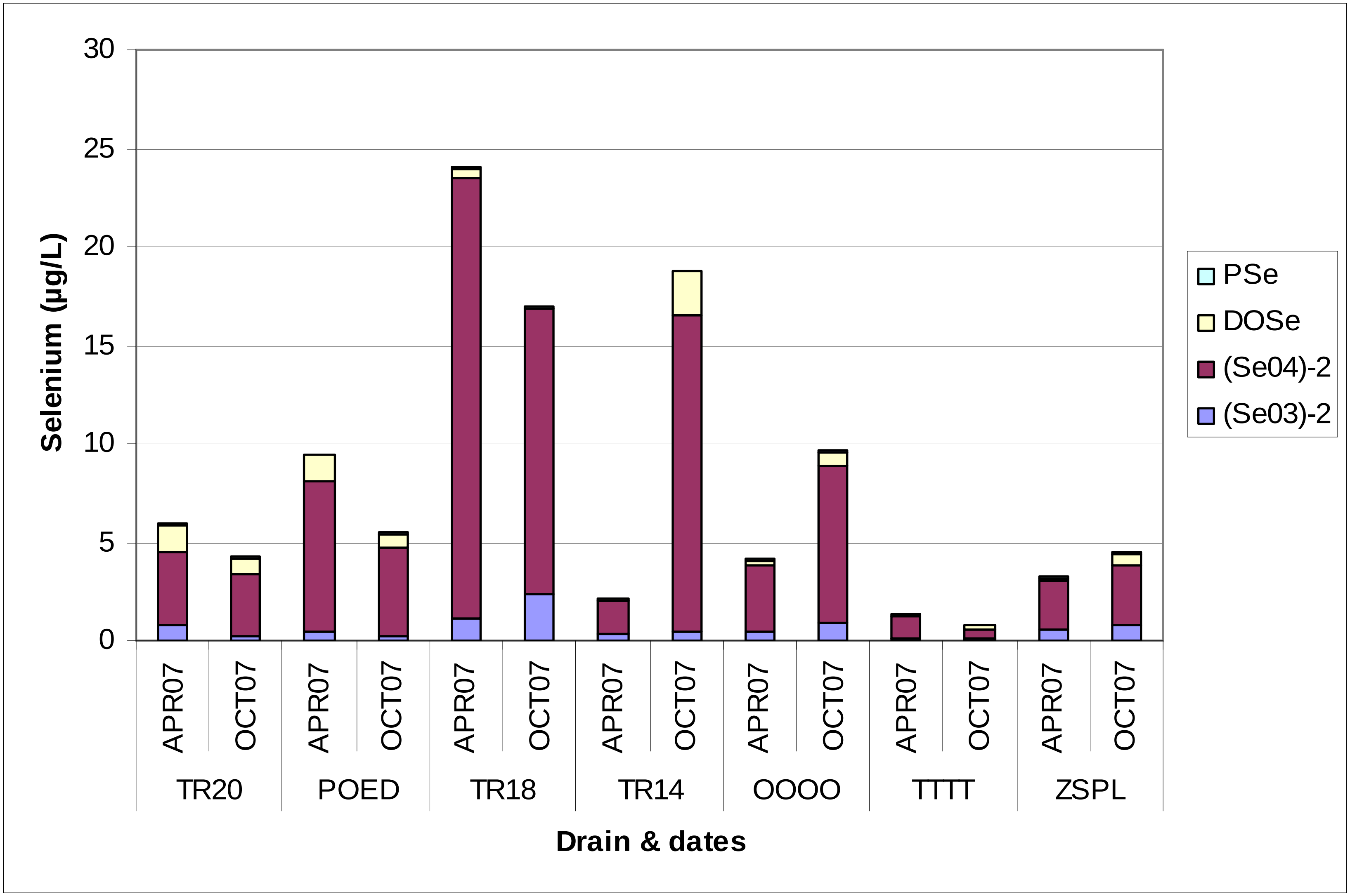

Figure 17. Speciation of total selenium in unfiltered water samples collected from seven drains during April and October 2007. Selenium species are: dissolved selenite (SeO_3^{-2}), dissolved selenate (SeO_4^{-2}), dissolved organic selenium (DOSe), and particulate selenium (PSe). Codes for drains are given in table 1.

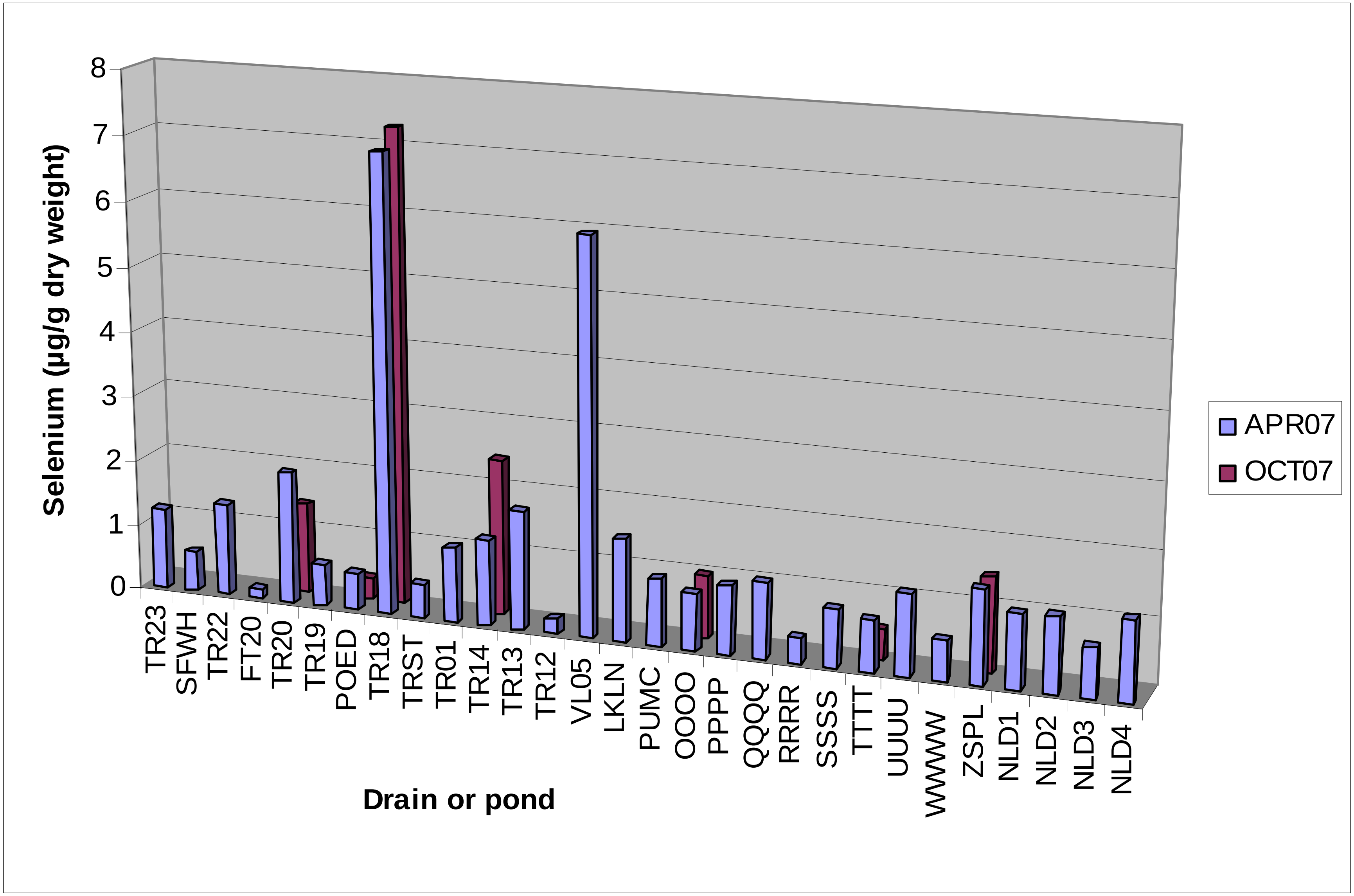

Figure 18. Total selenium concentrations in sediment samples from 29 drains or ponds in April and October 2007. Twenty-nine drains or ponds were sampled in April, whereas only seven drains were sampled in October. Codes for drains or ponds are given in table 1.

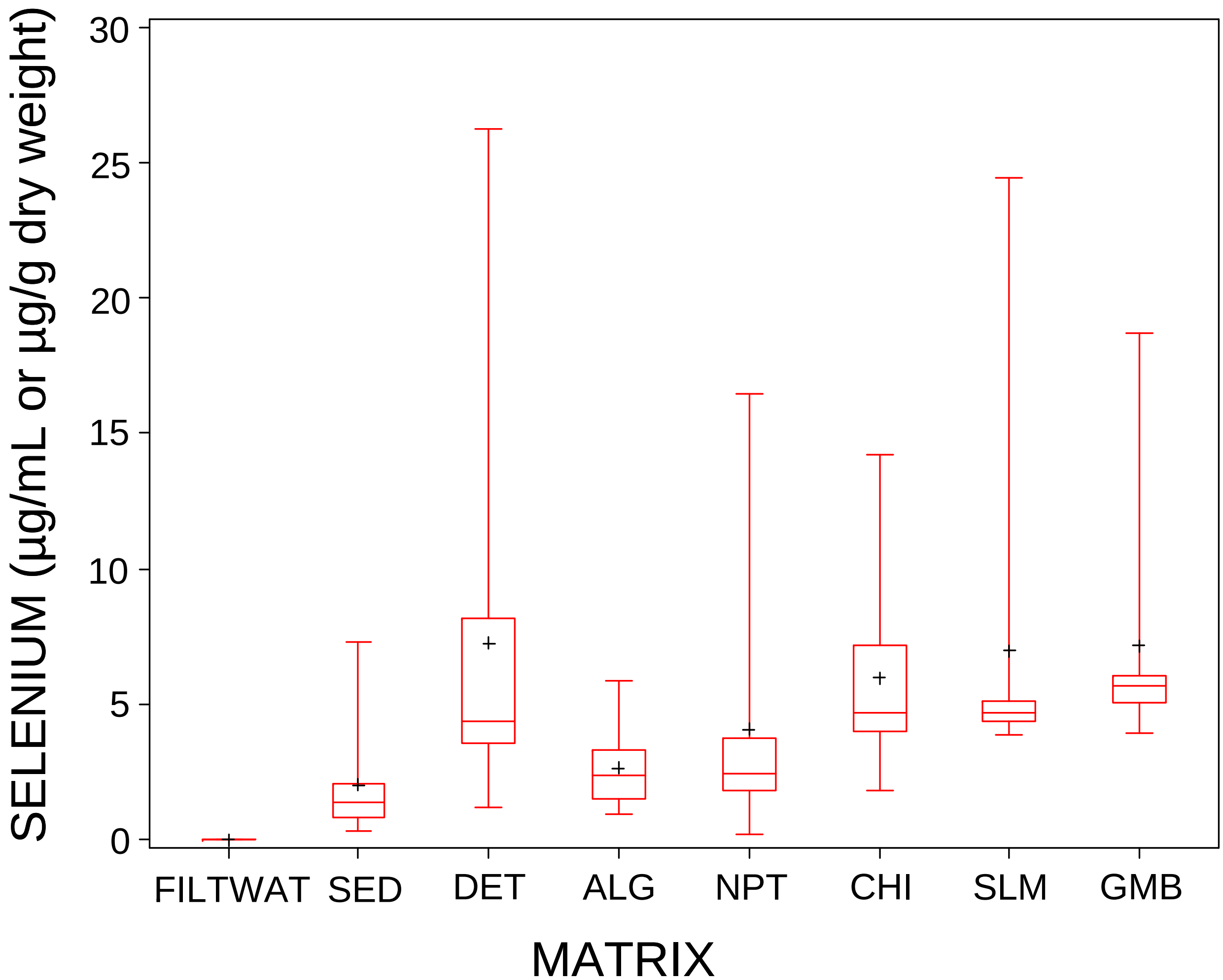

Figure 19. Total selenium concentrations (µg/mL or µg/g dry weight; all values are roughly equivalent to "parts per million") in filtered water (FILTWAT), sediment (SED), particulate organic detritus (DET), filamentous algae (ALG), net plankton (NPT), midge larvae (CHI), sailfin mollies (SLM), and western mosquitofish (GMB). Box plots are constructed from geometric mean values for the various matrices collected from as many as seven intensively monitored drains during April and October 2007.

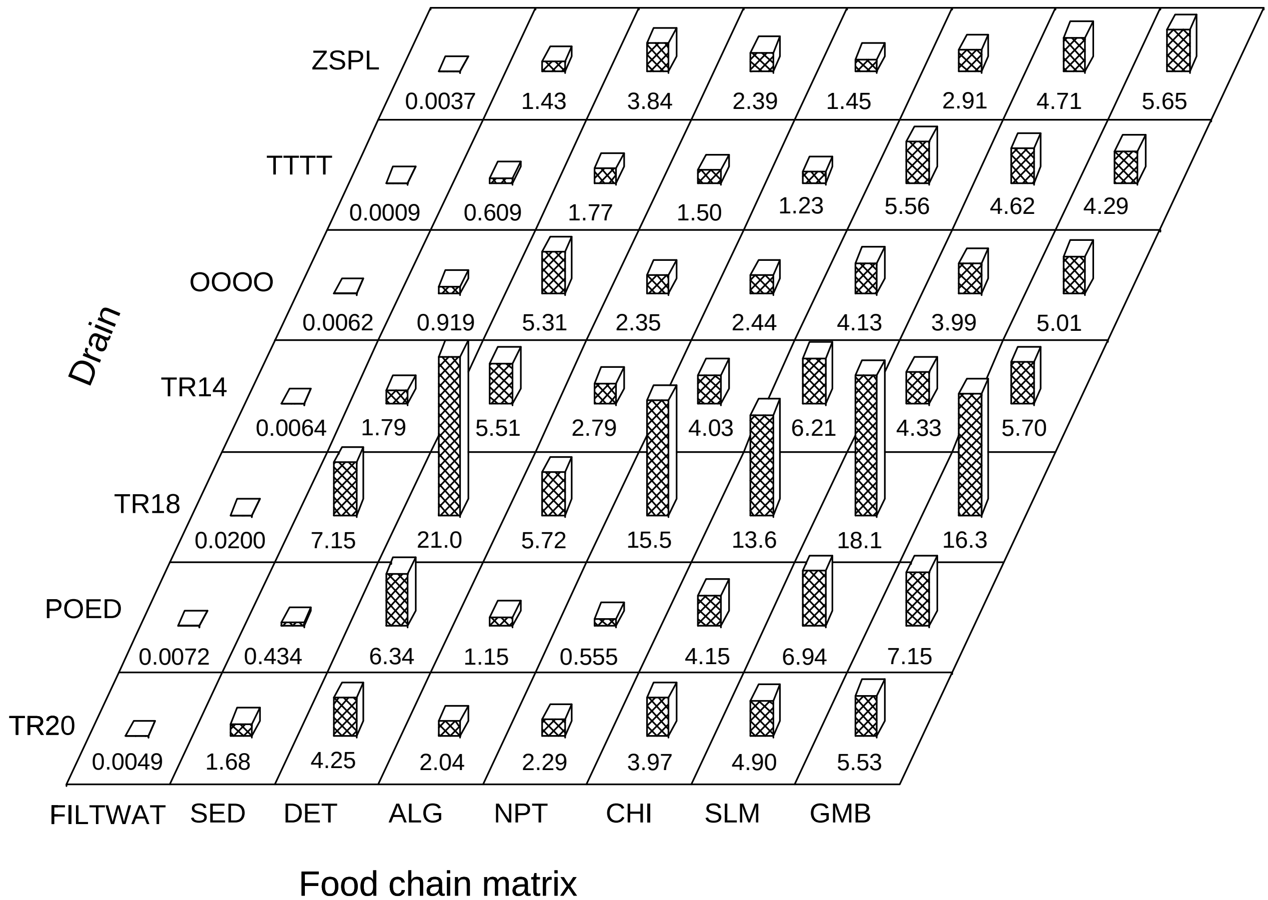

Figure 20. Total selenium concentrations (µg/mL or µg/g dry weight) in filtered water (FILTWAT), sediment (SED), particulate organic detritus (DET), filamentous algae (ALG), net plankton (NPT), midge larvae (CHI), sailfin molly (SLM), and western mosquitofish (GMB) from seven intensively monitored agricultural drains (codes for drains are given in table 1). Values are unweighted geometric grand means (N=2) for samples collected in April and October 2007.

Table 1. List of 29 agricultural drains or ponds selected for study as part of the baseline selenium monitoring project.

[**Abbreviations**: ID, identification code; °, degrees; ', minutes; N, north latitude; W, west longitude]

Drain or pond	Drain ID	Geospatial coordinates of fixed sampling stations
Trifolium 23	TR23	33°08.843'N, 115°47.626'W
San Felipe Wash	SFWH	33º08.380'N, 115º47.411'W
Trifolium 22	TR22	33º07.707'N, 115º46.860'W
Former Trifolium 20[1]	FT20	33º06.651'N, 115º46.204'W
Trifolium 20[2]	TR20	33º06.519'N, 115º45.927'W
Trifolium 19	TR19	33º06.281'N, 115º45.606'W
Poe	POED	33º06.053'N, 115º45.112'W
Trifolium 18	TR18	33º05.939'N, 115º44.141'W
Trifolium Storm	TRST	33º05.829'N, 115º43.607'W
Trifolium 1	TR01	33º05.258'N, 115º43.088'W
Trifolium 14A	TR14	33º05.445'N, 115º42.046'W
Trifolium 13	TR13	33º05.793'N, 115º41.528'W
Trifolium 12	TR12	33º06.172'N, 115º41.107'W
Lack & Lindsey Pond	LKLN	33º08.845'N, 115º39.080'W
Vail 5 Pond[3]	VL05	33º10.264'N, 115º37.802'W
Pumice Pond	PUMC	33º10.596'N, 115º37.448'W
O	OOOO	33º12.353'N, 115º35.234'W
P	PPPP	33º12.785'N, 115º35.078'W
Q	QQQQ	33º13.398'N, 115º35.087'W
R	RRRR	33º13.645'N, 115º35.180'W
S	SSSS	33º14.079'N, 115º35.205'W
T	TTTT	33º14.511'N, 115º35.056'W
U	UUUU	33º14.949'N, 115º35.418'W
W	WWWW	33º15.829'N, 115º35.607'W
Z Spill	ZSPL	33º16.688'N, 115º36.135'W
Niland 1	NLD1	33º17.073'N, 115º36.249'W
Niland 2	NLD2	33º17.563'N, 115º36.530'W
Niland 3	NLD3	33º17.972'N, 115º36.713'W
Niland 4	NLD4	33º18.428'N, 115º37.098'W

[1] Former Trifolium 20 Drain occasionally is referred to as "Trifolium 20 Drain."

[2] Trifolium 20 Drain occasionally is referred to as "Trifolium 20A Drain."

[3] Vail 5 Pond also is referred to as "McKendry Pond."

Table 2. Spearman rank correlation coefficients and *P* values for water quality variables measured from 29 agricultural drains or ponds during April, July, and October 2007, and January 2008.

[N=116. *P*, level of significance; N, sample size; <, less than]

Variable	Temperature	Dissolved oxygen	pH	Specific conductance	Turbidity	Total suspended solids	Total selenium
Temperature	1.00	[1]-0.47, *P*<0.0001	-0.12, *P*=0.1997	-0.02, *P*=0.8509	-0.12, *P*=0.2175	0.15, *P*=0.1151	-0.08, *P*=0.3812
Dissolved oxygen		1.00	[1]0.28, *P*<0.0022	-0.09, *P*=0.3116	-0.05, *P*=0.5802	-0.25, *P*=0.0070	-0.02, *P*=0.8481
pH			1.00	-0.07, *P*=0.4319	0.06, *P*=0.5103	0.05, *P*=0.5609	[1]-0.32, *P*=0.0005
Specific conductance				1.00	[1]-0.28, *P*=0.0019	[1]-0.33, *P*=0.0003	[1]0.56, *P*<0.0001
Turbidity					1.00	[1]0.35, *P*<0.0001	-0.20, *P*=0.0300
Total suspended solids						1.00	-0.07, *P*=0.4817
Total selenium							1.00

[1] Significant according to an adjusted Bonferroni *P*=0.0024 for 21 simultaneous comparisons.

Table 3. Summary of water quality variables from 29 combined agricultural drains, April 2007-January 2008.

[Within a column, geometric means followed by the same capital letters are not significantly different (*P*>0.05) according to Tukey's studentized range test. °C, degrees Celsius; mg/L, milligrams per liter; mS/cm, millisiemens per centimeter; NTUs, Nephalometric Turbidity Units; µg/L, micrograms per liter; *P*, level of significance; <, less than]

Sample date or F-statistic	Temperature (°C)	Dissolved oxygen (mg/L)	pH	Specific conductance (mS/cm)	Turbidity (NTUs)	Total suspended solids (mg/L)	Total selenium (µg/L)
April 2007	18.49 C	7.07 AB	7.71 AB	3.60 A	4.67 A	64.2 A	4.55 A
July 2007	26.05 A	4.67 C	7.61 B	3.07 A	6.95 A	89.8 A	3.99 A
October 2007	21.68 B	5.81 BC	7.94 A	3.27 A	3.91 A	65.4 A	4.36 A
January 2008	12.91 D	8.38 A	7.85 AB	3.45 A	10.32 A	61.1 A	5.66 A
$F_{3,112}$	[2]94.04	[2]8.53	[1]3.34	0.31	0.83	0.84	0.18

[1] $P<0.05$

[2] $P<0.0001$

Table 4. Summary of moisture and total selenium concentrations in water, sediment, aquatic food-chain organisms, and surrogate fish species from combined samples collected in seven intensively monitored drains during April and October 2007.

[Selenium concentrations in water (expressed as µg/mL) and other matrices (expressed as µg/g dry weight) are equivalent to "parts per million." **Mean, Moisture**: Angular-transformed mean. **Mean, Se**: Geometric mean. **Abbreviations**: µg/mL, micrograms per milliliter; µg/g, microgram per gram; N, number of samples; %, percent; Se, total selenium; n/a, not applicable; ---, not measured]

Matrix	N	Moisture (%)		Se (µg/mL or µg/g dry weight)	
		Mean	Range	Mean	Range
Unfiltered water[1]	28	n/a	n/a	0.00523	0.000714-0.0242
Filtered water	28	n/a	n/a	0.00515	0.000700-0.0241
Sediment	14	48.6	23.6-60.7	1.33	0.330-7.28
Particulate organic detritus	42	77.0	66.8-84.4	5.27	0.850-28.9
Filamentous algae	42	67.2	54.6-83.4	2.27	0.880-5.99
Net plankton	42	---	---	2.31	0.150-19.3
Midge larvae	42	79.6	68.4-87.9	5.13	1.39-15.4
Sailfin molly	37	76.0	71.7-80.4	6.06	3.71-25.1
Western mosquitofish	41	77.3	74.0-81.3	6.43	3.72-20.2

[1] Computed from the sum of total dissolved selenium (that is, selenium in filtered water) and particulate selenium (selenium retained on a 0.45-µm Geotech dispos-a-filter™ capsule).

Table 5. Temporal and spatial variations in total dissolved selenium content (µg/L) of filtered water samples collected from seven intensively monitored drains during April and October 2007.

[Within a column, geometric means followed by the same capital letters are not significantly different (*P*>0.05) according to Tukey's studentized range test. According to two-way analysis of variance, the interaction between main effects (drains and dates) was significant ($F_{6,14}$=536.79, *P*<0.0001). **Drain ID or ANOVA**: See table 1 for names of drains. µg/L, micrograms per liter; *P*, level of significance; >, greater than; F, F statistic; <, less than; ID, identification code; ANOVA, analysis of variance]

Drain ID or ANOVA	April 2007		October 2007		ANOVA for between-dates comparisons
	Mean	Range	Mean	Range	
TR20	5.86 C	5.78-5.95	4.17 D	4.08-4.26	$F_{1,2}$=172.22, *P*=0.0058
POED	9.47 B	9.23-9.72	5.45 C	5.31-5.60	$F_{1,2}$=221.59, *P*=0.0045
TR18	23.9 A	23.7-24.1	16.7 A	16.5-16.9	$F_{1,2}$=602.09, *P*=0.0017
TR14	2.17 F	2.14-2.20	18.8 A	18.4-19.3	$F_{1,2}$=6114.08, *P*=0.0002
OOOO	4.05 D	4.00-4.10	9.62 B	9.59-9.64	$F_{1,2}$=4696.67, *P*=0.0002
TTTT	1.07 G	1.04-1.10	0.767 E	0.700-0.840	$F_{1,2}$=12.17, *P*=0.0732
ZSPL	3.19 E	3.15-3.23	4.40 D	4.38-4.42	$F_{1,2}$=581.53, *P*=0.0017
ANOVA for among-drain comparisons	$F_{6,7}$=3201.91, *P*<0.0001		$F_{6,7}$=803.35, *P*<0.0001		

Table 6. Temporal and spatial measurements of total selenium in sediment samples collected from 22 extensively monitored drains or ponds during April 2007, and seven intensively monitored drains during April and October 2007.

[N=1 for all values. **Drain ID**: See table 1 for names of drains. N, sample size; ID, identification code; Se, total selenium; µg/g, micrograms per gram; ---, not measured]

Drain ID	Se (µg/g dry weight)	
	April 2007	October 2007
TR23	1.23	---
SFWH	0.61	---
TR22	1.42	---
FT20	0.15	---
TR20	2.03	1.39
TR19	0.65	---
POED	0.57	0.33
TR18	7.02	7.28
TRST	0.51	---
TR01	1.15	---
TR14	1.33	2.40
TR13	1.82	---
TR12	0.23	---
VL05	6.04	---
LKLN	1.58	---
PUMC	1.03	---
OOOO	0.87	0.97
PPPP	1.05	---
QQQQ	1.17	---
RRRR	0.38	---
SSSS	0.89	---
TTTT	0.79	0.47
UUUU	1.25	---
WWWW	0.62	---

Drain ID	Se (µg/g dry weight)	
	April 2007	October 2007
ZSPL	1.42	1.44
NLD1	1.14	---
NLD2	1.15	---
NLD3	0.76	---
NLD4	1.24	---

Table 7. Spearman rank correlations and P values for total selenium concentrations in sediment samples and selected sediment characteristics during April and October 2007.

[N=36. **Abbreviations**: N, sample size; Se, total selenium; µg/g, micrograms per gram; r_s, Spearman rank correlation coefficient; *P*, level of significance; >, greater than; mm, millimeters; %, percent; Eh, redox potential; mV, millivolts; °C, degrees Celsius; pH, hydrogen-ion concentration; <, less than]

Sediment characteristics		Se (µg/g)	
		r_s	*P*
Particle size:	>2 mm (%)	0.22	0.2031
	Sand (%)	-0.20	0.2544
	Silt (%)	0.54	[1]0.0007
	Clay (%)	-0.08	0.6364
Total organic carbon (%)		0.62	[1]<0.0001
Eh (mV)		-0.55	[1]0.0005
Temperature (°C)		-0.36	0.0326
pH		-0.12	0.4737

[1] Significant according to an adjusted Bonferroni *P*=0.00625 for 8 simultaneous comparisons.

Table 8. Temporal and spatial variations in total selenium content (µg/g dry weight) of particulate organic detritus samples collected from seven intensively monitored drains during April and October 2007.

[Within a column, geometric means followed by the same capital letters are not significantly different (P>0.05) according to Tukey's studentized range test. According to two-way analysis of variance, the interaction between main effects (drains and dates) was significant ($F_{6,28}$=3.66, P=0.0083). **Drain ID or ANOVA**: see table 1 for names of drains. P, level of significance; >, greater than; F, F statistic; ANOVA, analysis of variance]

Drain ID or ANOVA	April 2007		October 2007		ANOVA for between-dates comparisons
	Mean	Range	Mean	Range	
TR20	8.19 B	7.41-9.42	2.21 BC	1.76-2.61	$F_{1,4}$=89.94, P=0.0007
POED	10.3 B	8.40-11.7	3.91 B	2.44-6.55	$F_{1,4}$=10.15, P=0.0333
TR18	26.2 A	23.6-28.9	16.8 A	13.3-21.7	$F_{1,4}$=8.47, P=0.0437
TR14	6.64 BC	6.41-6.98	4.57 B	3.79-5.72	$F_{1,4}$=9.27, P=0.0382
OOOO	7.52 B	4.86-9.43	3.75 B	2.54-4.75	$F_{1,4}$=5.62, P=0.0768
TTTT	2.67 D	2.64-2.71	1.18 C	0.850-1.48	$F_{1,4}$=23.81, P=0.0082
ZSPL	4.18 CD	3.16-5.40	3.52 B	3.37-3.62	$F_{1,4}$=1.19, P=0.3362
ANOVA for among-drain comparisons	$F_{6,14}$=39.46, P<0.0001		$F_{6,14}$=23.13, P<0.0001		

Table 9. Temporal and spatial variations in total selenium content (µg/g dry weight) of filamentous algae samples collected from seven intensively monitored drains during April and October 2007.

[Within a column, geometric means followed by the same capital letter are not significantly different (*P*>0.05) according to Tukey's studentized range test. According to two-way analysis of variance, the interaction between main effects (drains and dates) was significant ($F_{6,28}$=135.15, *P*<0.0001). **Drain ID or ANOVA**: see table 1 for names of drains. **Abbreviations**: µg/g, micrograms per gram; *P*, level of significance; >, greater than; F, F statistic; <, less than; ANOVA, analysis of variance]

Drain ID or ANOVA	April 2007		October 2007		ANOVA for between-dates comparisons
	Mean	Range	Mean	Range	
TR20	1.67 C	1.33-2.01	2.48 D	2.44-2.53	$F_{1,4}$=10.45, *P*=0.0319
POED	0.990 D	0.880-1.07	1.33 E	1.32-1.35	$F_{1,4}$=23.99, *P*=0.0081
TR18	5.59 A	5.41-5.74	5.85 A	5.73-5.99	$F_{1,4}$=4.43, *P*=0.1032
TR14	2.35 B	2.19-2.48	3.30 C	3.28-3.32	$F_{1,4}$=82.23, *P*=0.0008
OOOO	1.73 BC	1.57-1.99	3.18 C	3.16-3.22	$F_{1,4}$=72.32, *P*=0.0010
TTTT	2.35 B	1.97-2.63	0.960 F	0.950-0.970	$F_{1,4}$=100.41, *P*=0.0006
ZSPL	1.51 C	1.45-1.56	3.77 B	3.69-3.88	$F_{1,4}$=1197.86, *P*<0.0001
ANOVA for among-drain comparisons	$F_{6,14}$=60.48, *P*<0.0001		$F_{6,14}$=4246.57, *P*<0.0001		

Table 10. Temporal and spatial variations in total selenium content (µg/g dry weight) of net plankton samples collected from seven intensively monitored drains during April and October 2007.

[Within a column, geometric means followed by the same capital letter are not significantly different (*P*>0.05) according to Tukey's studentized range test. According to two-way analysis of variance, the interaction between main effects (drains and dates) was significant ($F_{6,28}$=13.58, *P*<0.0001). **Drain ID or ANOVA**: see table 1 for names of drains. µg/g, micrograms per gram; *P*, level of significance; >, greater than; F, F statistic; <, less than; ANOVA, analysis of variance]

Drain ID or ANOVA	April 2007		October 2007		ANOVA for between-dates comparisons
	Mean	Range	Mean	Range	
TR20	2.74 BC	2.41-3.34	1.91 BC	1.56-2.23	$F_{1,4}$=6.10, *P*=0.0690
POED	1.83 C	1.45-2.08	0.168 E	0.150-0.210	$F_{1,4}$=217.24, *P*=0.0001
TR18	14.6 A	11.9-17.0	16.5 A	12.9-19.3	$F_{1,4}$=0.51, *P*=0.5131
TR14	4.33 B	4.27-4.41	3.75 B	2.88-4.54	$F_{1,4}$=1.11, *P*=0.3522
OOOO	2.10 BC	1.97-2.29	2.84 B	2.58-3.05	$F_{1,4}$=20.21, *P*=0.0109
TTTT	2.17 BC	1.40-4.80	0.698 D	0.550-1.05	$F_{1,4}$=6.42, *P*=0.0644
ZSPL	2.69 BC	2.08-3.41	0.784 CD	0.390-1.47	$F_{1,4}$=9.04, *P*=0.0397
ANOVA for among-drain comparisons	$F_{6,14}$=16.71, *P*<0.0001		$F_{6,14}$=59.71, *P*<0.0001		

Table 11. Temporal and spatial variations in total selenium content (µg/g dry weight) of midge larvae samples collected from seven intensively monitored drains during April and October 2007.

[Within a column, geometric means followed by the same capital letter are not significantly different (*P*>0.05) according to Tukey's studentized range test. According to two-way analysis of variance, the interaction between main effects (drains and dates) was significant ($F_{6,28}$=33.36, *P*<0.0001). **Drain ID or ANOVA**: see table 1 for names of drains. **Abbreviations**: µg/g, micrograms per gram; *P*, level of significance; >, greater than; <, less than; ANOVA, analysis of variance]

Drain ID or ANOVA	April 2007		October 2007		ANOVA for between-dates comparisons
	Mean	Range	Mean	Range	
TR20	8.69 B	8.29-9.29	1.82 C	1.39-2.21	$F_{1,4}$=120.36, *P*=0.0004
POED	4.30 C	3.69-4.76	4.01 B	3.01-5.45	$F_{1,4}$=0.14, *P*=0.7257
TR18	13.1 A	12.7-13.4	14.2 A	12.8-15.4	$F_{1,4}$=2.00, *P*=0.2300
TR14	7.17 B	6.86-7.42	5.37 B	5.31-5.40	$F_{1,4}$=146.22, *P*=0.0003
OOOO	4.28 CD	3.76-4.79	3.99 B	3.62-4.26	$F_{1,4}$=0.69, *P*=0.4532
TTTT	5.05 C	4.58-5.39	6.13 B	5.89-6.49	$F_{1,4}$=11.32, *P*=0.0282
ZSPL	3.39 D	3.18-3.56	2.50 C	2.30-2.62	$F_{1,4}$=33.34, *P*=0.0045
ANOVA for among-drain comparisons	$F_{6,14}$=95.63, *P*<0.0001		$F_{6,14}$=54.43, *P*<0.0001		

Table 12. Temporal and spatial variations in total selenium content (µg/g dry weight) of sailfin molly samples collected from seven intensively monitored drains during April and October 2007.

[Within a column, geometric means followed by the same capital letter are not significantly different (*P*>0.05) according to Tukey's studentized range test. According to two-way analysis of variance, the interaction between main effects (drains and dates) was significant ($F_{6,23}$=62.89, *P*<0.0001). **Drain ID or ANOVA**: see table 1 for names of drains. **Abbreviations**: µg/g, micrograms per gram; *P*, level of significance; >, greater than; F, F statistic; <, less than; ANOVA, analysis of variance]

Drain ID or ANOVA	April 2007		October 2007		ANOVA for between-dates comparisons
	Mean	Range	Mean	Range	
TR20	5.11 C	4.86-5.38	4.69 B	4.62-4.79	$F_{1,3}$=4.64, *P*=0.1203
POED	9.91 B	9.71-10.3	4.86 B	4.65-5.27	$F_{1,4}$=250.34, *P*<0.0001
TR18	13.5 A	12.8-13.8	24.5 A	24.0-25.1	$F_{1,4}$=442.35, *P*<0.0001
TR14	4.34 DE	4.23-4.51	4.31 B	3.97-4.58	$F_{1,4}$=0.02, *P*=0.8917
OOOO	3.85 E	3.85-3.85	4.13 B	3.71-4.50	$F_{1,2}$=0.38, *P*=0.6021
TTTT	4.68 CD	4.65-4.72	4.55 B	4.36-4.92	$F_{1,3}$=0.34, *P*=0.5994
ZSPL	4.88 CD	4.74-5.03	4.55 B	4.16-4.85	$F_{1,3}$=1.23, *P*=0.3483
ANOVA for among-drain comparisons	$F_{6,9}$=330.71, *P*<0.0001		$F_{6,14}$=269.63, *P*<0.0001		

Table 13. Temporal and spatial variations in total selenium content (µg/g dry weight) of western mosquitofish samples collected from seven intensively monitored drains during April and October 2007.

[Within a column, geometric means followed by the same capital letter are not significantly different (P>0.05) according to Tukey's studentized range test. According to two-way analysis of variance, the interaction between main effects (drains and dates) was significant (F6,27=20.73, P<0.0001). Drain ID or ANOVA: see table 1 for names of drains. µg/g, micrograms per gram; P, level of significance; >, greater than; F, F statistic; <, less than; ANOVA, analysis of variance]

Drain ID or ANOVA	April 2007		October 2007		ANOVA for between-dates comparisons
	Mean	Range	Mean	Range	
TR20	6.03 C	5.90-6.21	5.07 CD	4.98-5.22	$F_{1,4}$=65.15, *P*=0.0013
POED	8.86 B	8.35-9.49	5.76 BC	5.44-5.97	$F_{1,4}$=83.18, *P*=0.0008
TR18	18.7 A	17.9-20.2	14.1 A	13.2-14.7	$F_{1,4}$=30.08, *P*=0.0054
TR14	5.58 C	5.50-5.66	5.83 B	5.68-6.03	$F_{1,4}$=5.08, *P*=0.0872
OOOO	5.63 C	5.53-5.70	4.46 DE	4.20-4.76	$F_{1,4}$=38.96, *P*=0.0034
TTTT	4.70 D	4.62-4.78	3.91 E	3.72-4.09	$F_{1,4}$=38.74, *P*=0.0034
ZSPL	5.54 C	5.38-5.71	5.76 BC	5.49-6.00	$F_{1,4}$=0.94, *P*=0.4038
ANOVA for among-drain comparisons	$F_{6,13}$=396.27, *P*<0.0001		$F_{6,14}$=228.61, *P*<0.0001		

Table 14. Spearman rank correlation coefficients for total selenium concentrations measured in water, sediment, selected food-chain taxa, and surrogate fish species from seven agricultural drains during April and October 2007.

[Except for autocorrelations (where only the correlation coefficient is shown), values are correlation coefficient and *P* value (in all instances, N=14).

Abbreviations: *P*, level of significance; N, sample size]

Variable	Filtered water	Sediment	Detritus	Filamentous algae	Net plankton	Midge larvae	Sailfin molly	Western mosquitofish
Filtered water	1.00	0.57, *P*=0.0304	0.62, *P*=0.0165	0.56, *P*=0.0371	0.48, *P*=0.0814	0.27, *P*=0.3418	0.35, *P*=0.2145	0.73, *P*=0.0029
Sediment		1.00	0.49, *P*=0.0752	[1]0.78, *P*=0.0010	0.75, *P*=0.0022	0.36, *P*=0.2085	0.34, *P*=0.2398	0.58, *P*=0.0304
Detritus			1.00	0.26, *P*=0.3664	0.60, *P*=0.0233	0.61, *P*=0.0209	0.49, *P*=0.0752	[1]0.85, *P*=0.0001
Filamentous algae				1.00	0.66, *P*=0.0100	0.18, *P*=0.5426	0.05, *P*=0.8520	0.38, *P*=0.1854
Net plankton					1.00	0.60, *P*=0.0233	0.16, *P*=0.5733	0.38, *P*=0.1854
Midge larvae						1.00	0.35, *P*=0.2207	0.48, *P*=0.0814
Sailfin molly							1.00	0.62, *P*=0.0186
Western mosquitofish								1.00

[1] Significant according to an adjusted Bonferroni P=0.0018 for 28 simultaneous comparisons.

Appendix: Raw Data from Field and Laboratory Measurements of Water, Sediment, and Various Aquatic Biota, Including Fish

Table A1. Raw data for water quality variables measured from 29 drains or ponds during April 2007, July 2007, October 2007, and January 2008.

[**TSS** and **Se**: values are measured to three significant figures. One or more trailing zeros may be included to facilitate proper within-column alignment of measured values. **Abbreviations**: mm/dd/yyyy, month/day/year; ID, identification code; hh:mm, hour:minute; Temp, temperature; °C, degrees Celsius; DO, dissolved oxygen; mg/L, milligrams per liter; % sat, percent saturation; pH, hydrogen-ion concentration; mS/cm, milliseimens per centimeter; NTUs, nephelometric units; TSS, total suspended solids; Se, total selenium; µg/L, micrograms per liter]

Date (mm/dd/yyyy)	Drain or pond	Drain or Pond ID	Time (hh:mm)	Temp (°C)	DO (mg/L)	DO (% sat)	pH	Conductivity (mS/cm at 25°C)	Turbidity (NTUs)	TSS (mg/L)	Se (µg/L)
4/19/2007	Trifolium 23	TR23	7:17	16.2	7.16	72.1	7.44	1.95	24.7	30.2	3.83
4/19/2007	San Felipe Wash	SFWH	8:56	14.52	7.88	81.3	7.8	1.91	0.0	9.00	2.82
4/19/2007	Trifolium 22	TR22	11:07	17.85	6.27	66.4	7.92	16.75	0.0	89.0	7.6
4/19/2007	Former Trifolium 20	FT20	13:20	20.65	8.23	91.4	7.1	2.582	0.0	2.40	5.80
4/20/2007	Trifolium 20	TR20	6:50	15.7	10.7	110.8	8.32	10.12	0.0	25.6	5.94
4/20/2007	Trifolium 19	TR19	9:15	17.59	8.73	93.6	7.1	5.41	9.8	30.3	3.12
4/17/2007	Poe Rd	POED	7:00	14.75	6.09	60.5	7.67	5.61	20.8	29.1	9.45
4/20/2007	Trifolium 18	TR18	13:07	19.41	14.78	164.8	7.39	12.64	0.0	12.6	24.1
4/26/2007	Trifolium Storm	TRST	8:20	15.5	8.09	85.6	7.67	18.48	0.0	25.9	47.1
4/26/2007	Trifolium 1	TR01	9:50	19.52	5.01	53.5	7.07	2.582	0.0	30.8	4.00
4/21/2007	Trifolium 14A	TR14	9:46	14.2	8.45	82.2	8.53	2.822	0.0	126.	2.23
4/21/2007	Trifolium 13	TR13	7:00	13.2	6.75	64.4	7.65	4.466	33.0	50.2	5.68
4/26/2007	Trifolium 12	TR12	12:15	22.75	6.46	71.0	7.83	1.16	0.0	188.	3.63
4/26/2007	Vail 5 Pond	VL05	6:23	16.92	1.28	12.3	7.48	3.046	0.0	480.	5.35
4/20/2007	Lack & Lindsey Pond	LKLN	15:00	20.12	9.38	104.8	8.11	4.468	0.0	28.7	4.19
4/21/2007	Pumice Pond	PUMC	13:19	18.41	7.68	81.9	7.51	2.934	0.0	89.7	6.95

Date (mm/dd/yyyy)	Drain or pond	Drain or Pond ID	Time (hh:mm)	Temp (°C)	DO (mg/L)	DO (% sat)	pH	Conductivity (mS/cm at 25°C)	Turbidity (NTUs)	TSS (mg/L)	Se (µg/L)
4/28/2007	O	OOOO	6:53	21.09	95.1	8.4	7.77	2.366	177.9	167.	4.16
4/27/2007	P	PPPP	6:20	19.9	6.67	73.4	7.84	1.822	364.0	322.	3.48
4/27/2007	Q	QQQQ	7:55	17.98	7.52	79.3	8.09	4.888	239.5	142.	15.9
4/27/2007	R	RRRR	10:20	21.75	5.06	57.9	7.2	2.29	0.0	156.	2.82
4/27/2007	San Felipe Wash	SSSS	11:51	24.64	6.14	71.9	7.94	2.144	0.0	61.8	1.57
4/27/2007	T	TTTT	13:12	27.83	7.42	95.6	8.29	3.588	58.2	53.6	1.09
4/24/2007	U	UUUU	14:19	24.01	7.03	83.1	8.13	3.354	0.0	83.5	2.12
4/24/2007	W	WWWW	12:13	20.48	8.31	91.7	7.76	1.685	0.0	641.	4.01
4/23/2007	Z Spill	ZSPL	7:58	15.51	9.08	90.0	7.8	1.656	27.9	25.7	3.23
4/23/2007	Niland 1	NLD1	9:10	17.21	5.38	56.0	7.37	2.824	74.5	66.7	2.85
4/24/2007	Niland 2	NLD2	10:45	19.92	6.83	76.8	7.7	6.667	0.0	99.2	3.04
4/24/2007	Niland 3	NLD3	8:02	16.88	9.15	93.8	8.07	1.311	139.1	204.	2.04
4/24/2007	Niland 4	NLD4	6:25	19.66	5.08	54.1	7.19	2.088	122.7	110.	1.98
7/12/2007	Trifolium 23	TR23	5:34	22.53	3.71	43.0	7.39	2.168	58.4	66.3	3.8
7/12/2007	San Felipe Wash	SFWH	5:50	24.29	4.3	50.5	7.47	1.92	91.9	16.6	2.18
7/12/2007	Trifolium 22	TR22	6:08	23.24	4.16	49.0	7.61	3.554	61.8	72.5	9.4
7/12/2007	Former Trifolium 20	FT20	6:32	25.69	6.12	75.0	7.48	2.591	0.0	21.9	5.81
7/12/2007	Trifolium 20	TR20	7:12	24.48	3.52	42.8	7.33	2.095	0.0	46.4	4.1
7/12/2007	Trifolium 19	TR19	7:30	26.2	2.89	35.0	8.02	7.897	5.2	58.1	1.77
7/12/2007	Poe	POED	8:05	25.79	9	108.5	7.28	3.049	0.0	68.7	4.61
7/12/2007	Trifolium 18	TR18	8:28	22.04	0.75	40.0	7.18	8.805	0.0	50.2	17.2
7/12/2007	Trifolium Storm	TRST	9:28	23.61	11.22	138.4	7.81	10.79	0.0	38.5	30.9
7/12/2007	Trifolium 1	TR01	9:45	25.76	5.6	6.8	6.27	3.967	0.0	55.7	4.17
7/12/2007	Trifolium 14A	TR14	10:44	27.07	5.25	67.5	8.25	3.489	0.0	44.2	1.43
7/12/2007	Trifolium 13	TR13	10:23	26.07	6.02	75.4	7.36	2.3688	0.0	100.	3.44
7/12/2007	Trifolium 12	TR12	11:38	28.7	6.23	81.9	7.64	4.035	0.0	369.	6.9
7/13/2007	Vail 5 Pond	VL05	11:03	29.66	7.67	103.3	8.11	2.964	0.0	26.3	2.96
7/12/2007	Lack & Lindsey Pond	LKLN	12:02	30.08	2.03	27.0	7.55	9.342	0.0	66.2	4.11
7/13/2007	Pumice Pond	PUMC	11:22	26.95	5.93	76.8	7.51	2.484	0.0	230.	5.15
7/13/2007	O	OOOO	10:07	25.65	6.01	74.9	8	2.361	123.4	156.	3.81
7/13/2007	P	PPPP	9:49	26.91	6.3	79.2	7.87	1.723	0.0	157.	2.6
7/13/2007	Q	QQQQ	9:33	26.39	6.31	79.2	7.89	3.495	70.9	103.	8.66

Date (mm/dd/yyyy)	Drain or pond	Drain or Pond ID	Time (hh:mm)	Temp (°C)	DO (mg/L)	DO (% sat)	pH	Conductivity (mS/cm at 25°C)	Turbidity (NTUs)	TSS (mg/L)	Se (µg/L)
7/13/2007	R	RRRR	9:15	28.52	3.42	43.8	7.73	3.543	156.7	138.	3.93
7/13/2007	San Felipe Wash	SSSS	8:56	28.56	2.79	36.1	7.74	3.12	103.4	68.7	2.15
7/13/2007	T	TTTT	8:39	27.74	3.27	42.5	8.3	2.495	0.0	78.5	1.43
7/13/2007	U	UUUU	8:21	28.2	4.05	52.5	7.84	1.503	0.0	65.3	1.87
7/13/2007	W	WWWW	7:54	25.35	7.07	78.6	7.5	2.169	331.0	233.	4.32
7/13/2007	Z Spill	ZSPL	7:23	25.67	3.26	38.1	7.55	1.858	4.1	429.	4.83
7/13/2007	Niland 1	NLD1	6:54	25.43	4.15	50.9	7.25	2.25	43.3	252.	2.24
7/13/2007	Niland 2	NLD2	6:31	24.98	4.52	55.1	7.61	2.049	185.9	143.	2.46
7/13/2007	Niland 3	NLD3	6:11	25.95	5.53	66.9	7.78	1.62	156.7	275.	2.46
7/13/2007	Niland 4	NLD4	5:50	26.06	5.27	63.2	7.67	1.908	184.0	144.	2.00
10/15/2007	Trifolium 23	TR23	6:57	22.05	6.5	75.3	7.77	2.62	37.9	295.0	5.36
10/15/2007	San Felipe Wash	SFWH	7:30	17.89	5.94	63.2	8.11	2.28	0.0	68.8	2.29
10/15/2007	Trifolium 22	TR22	9:52	19.48	6.22	68.6	7.96	3.17	0.0	71.6	8.40
10/15/2007	Former Trifolium 20	FT20	9:14	26.29	6.86	86.0	7.31	2.74	0.0	8.0	6.50
10/11/2007	Trifolium 20	TR20	6:43	18.83	5.89	63.9	8.04	1.16	100.0	597.0	4.26
10/11/2007	Trifolium 19	TR19	9:42	18.38	4.86	54.7	8.79	13.97	0.0	10.4	0.97
10/11/2007	Poe	POED	12:20	26.72	6.99	88.5	7.94	3.18	0.0	38.0	5.45
10/12/2007	Trifolium 18	TR18	6:37	19.35	0.96	10.9	7.59	10.54	3.4	10.0	16.80
10/12/2007	Trifolium Storm	TRST	9:28	17.3	11.12	119.9	8.09	8.89	0.0	10.6	20.90
10/12/2007	Trifolium 1	TR01	11:14	20.3	3.78	42.4	6.14	3.34	25.3	88.0	5.46
10/15/2007	Trifolium 14A	TR14	11:59	31.26	12.63	176.6	7.7	9.02	0.0	48.4	18.85
10/15/2007	Trifolium 13	TR13	15:11	24.32	4.59	55.6	7.91	3.4	26.8	47.4	4.65
10/12/2007	Trifolium 12	TR12	12:51	25.07	7.75	95.2	8.14	3	0.0	53.2	4.78
10/11/2007	Vail 5 Pond	VL05	15:17	27.56	0.15	1.9	8.46	2.73	0.0	116.0	2.41
10/12/2007	Lack & Lindsey Pond	LKLN	14:19	25.38	12.35	152.0	8.44	2.27	0.0	26.8	2.75
10/11/2007	Pumice Pond	PUMC	16:34	25.18	7.26	89.2	7.67	3.02	98.4	214.0	6.85
10/14/2007	O	OOOO	6:41	19.74	4.58	51.1	8	4.52	46.5	383.0	9.76
10/14/2007	P	PPPP	8:53	19.77	5.82	64.8	8.15	4.39	0.0	101.0	5.27
10/14/2007	Q	QQQQ	9:18	17.98	4.08	43.8	7.78	4.13	0.0	82.0	8.93
10/14/2007	R	RRRR	10:37	19.95	4.11	45.9	8.15	3.82	14.9	116.0	3.56
10/14/2007	San Felipe Wash	SSSS	11:05	20.38	4.62	51.9	8.04	3.16	145.0	68.9	2.91
10/14/2007	T	TTTT	12:20	22.15	7.34	84.9	8.29	2.11	6.4	26.0	0.79

Date (mm/dd/yyyy)	Drain or pond	Drain or Pond ID	Time (hh:mm)	Temp (°C)	DO (mg/L)	DO (% sat)	pH	Conductivity (mS/cm at 25°C)	Turbidity (NTUs)	TSS (mg/L)	Se (µg/L)
10/14/2007	U	UUUU	14:29	21.63	7.29	83.4	8.14	1.69	48.7	22.8	1.10
10/14/2007	W	WWWW	15:02	25.04	7.9	96.4	8.1	1.7	45.1	76.5	3.26
10/16/2007	Z Spill	ZSPL	6:57	20.35	5.59	62.5	7.75	2.41	0.0	158.0	4.52
10/16/2007	Niland 1	NLD1	9:45	19.58	8.6	94.5	7.67	1.79	0.0	83.2	1.76
10/16/2007	Niland 2	NLD2	10:24	19.06	8.19	89.2	8.15	2.13	0.0	62.0	2.05
10/16/2007	Niland 3	NLD3	11:24	22.81	7.75	90.8	8.29	1.87	0.0	339.0	3.05
10/16/2007	Niland 4	NLD4	11:57	21.81	8.28	95.2	8.14	2	46.0	49.0	1.36
1/10/2008	Trifolium 23	TR23	7:20	12.69	9.44	89.4	7.8	1.78	43.8	64.9	2.77
1/10/2008	San Felipe Wash	SFWH	7:50	11.13	105.8	11.6	8.28	1.96	0.0	27.2	2.36
1/10/2008	Trifolium 22	TR22	9:25	10.44	9.6	86.4	7.92	2.21	0.0	48.1	5.10
1/10/2008	Former Trifolium 20	FT20	9:50	17.25	8.34	87.3	7.33	2.37	0.0	6.7	4.80
1/10/2008	Trifolium 20	TR20	11:27	12.54	10.83	102.8	7.95	3.06	30.9	134.0	4.78
1/10/2008	Trifolium 19	TR19	11:45	12.31	10.09	96.7	7.48	7.35	0.0	49.5	1.44
1/10/2008	Poe	POED	13:52	18.38	9.16	98.6	7.69	3.74	0.0	16.5	5.94
1/10/2008	Trifolium 18	TR18	15:10	19.59	6.61	75.3	7.2	12.88	0.0	31.9	32.30
1/15/2008	Trifolium Storm	TRST	9:25	10.17	8.01	76.3	7.88	18	0.0	13.5	43.80
1/15/2008	Trifolium 1	TR01	8:18	11.48	6.13	56.9	6.47	3.68	0.0	50.3	6.61
1/11/2008	Trifolium 14A	TR14	12:20	16.46	9.13	96.9	8.49	9.36	11.3	24.5	3.20
1/11/2008	Trifolium 13	TR13	10:40	10.95	10.22	94.2	8.13	4.96	65.3	25.7	4.66
1/11/2008	Trifolium 12	TR12	14:00	18.1	9.53	102.4	8.04	4.56	0.0	70.3	9.19
1/12/2008	Vail 5 Pond	VL05	16:44	16.38	10.43	107.5	7.6	3.08	0.0	60.3	2.83
1/11/2008	Lack & Lindsey Pond	LKLN	15:33	17.63	11.72	123.8	7.98	2.51	23.1	34.1	4.20
1/12/2008	Pumice Pond	PUMC	15:44	17.06	4.64	48.5	8.02	3.42	106.0	155.0	6.56
1/12/2008	O	OOOO	7:17	10.46	9.41	84.8	8.25	2.09	323.0	351.0	4.35
1/12/2008	P	PPPP	8:01	9.58	10.14	89.3	8.07	1.58	66.5	68.7	2.19
1/12/2008	Q	QQQQ	8:40	9.09	6.68	60.4	8.02	11.08	112.0	72.5	64.50
1/12/2008	R	RRRR	9:28	9.48	9.54	83.9	8.06	1.87	149.0	590.0	2.67
1/12/2008	San Felipe Wash	SSSS	10:09	11.6	7.67	71.2	8.09	2.78	140.0	67.7	1.15
1/12/2008	T	TTTT	10:56	11.49	9.3	85.8	8.13	1.85	88.9	77.7	1.14
1/12/2008	U	UUUU	11:33	11.28	10.55	96.8	8.19	1.95	74.8	82.0	1.40
1/12/2008	W	WWWW	12:27	12.58	9.54	90.2	7.96	1.81	728.0	780.0	3.52
1/12/2008	Z Spill	ZSPL	13:58	11.65	9.7	89.8	7.94	2.12	0.0	71.7	3.86

Date (mm/dd/yyyy)	Drain or pond	Drain or Pond ID	Time (hh:mm)	Temp (°C)	DO (mg/L)	DO (% sat)	pH	Conductivity (mS/cm at 25°C)	Turbidity (NTUs)	TSS (mg/L)	Se (µg/L)
1/14/2008	Niland 1	NLD1	11:23	13.13	9.77	93.6	7.57	2.17	77.1	48.3	1.68
1/14/2008	Niland 2	NLD2	12:00	12.02	0.71	6.8	7.63	7.33	0.0	56.9	10.20
1/14/2008	Niland 3	NLD3	13:17	16.12	9.08	92.6	8.63	1.8	0.0	77.8	2.56
1/14/2008	Niland 4	NLD4	13:34	12.29	8.14	76.5	7.1	1.91	58.1	47.3	2.52

Table A2. Raw data for measurements of sediment in 29 drains or ponds during April 2007 and 7 drains during October 2007.

[**Se**: All Se values are measured to three significant figures. One or more trailing zeros may be included to facilitate proper within-column alignment of measured values. **Abbreviations**: mm/dd/yyyy, month/day/year; ID, identification code; Eh, redox potential; mV, millivolts; Temp, temperature, °C, degrees Celsius; pH, hydrogen-ion concentration; Se, total selenium; µg/g, micrograms per gram; %, percent; TOC, total organic carbon]

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Location	Eh (mV)	Temp (°C)	pH	Se (µg/g dry weight)	Moisture (%)	TOC (%)
4/19/2007	Trifolium 23	TR23	A	-253	11.9	7.39	1.23	48.0	3.2
4/19/2007	Trifolium 23	TR23	B	-395	11.7	7.14			
4/19/2007	Trifolium 23	TR23	C	-413	14.1	6.78			
4/19/2007	Trifolium 23	TR23	D	-422	12.2	7.13			
4/19/2007	Trifolium 23	TR23	E	-415	14.2	7.31			
4/19/2007	San Felipe Wash	SFWH	A	-65.3	14.8	7.30	0.61	31.4	0.7
4/19/2007	San Felipe Wash	SFWH	B	-87.8	15.3	7.41			
4/19/2007	San Felipe Wash	SFWH	C	-91.5	15.6	7.61			
4/19/2007	San Felipe Wash	SFWH	D	-111.4	16.2	7.42			
4/19/2007	San Felipe Wash	SFWH	E	-139.1	17.1	7.42			
4/19/2007	Trifolium 22	TR22	A	-388	17.8	7.60	1.42	57.5	2.5
4/19/2007	Trifolium 22	TR22	B	-419	17.4	7.22			
4/19/2007	Trifolium 22	TR22	C	-424	17.3	7.06			
4/19/2007	Trifolium 22	TR22	D	-426	17.7	7.13			
4/19/2007	Trifolium 22	TR22	E	-432	18.0	7.05			
4/19/2007	Former Trifolium 20	FT20	A	50.4	25.3	7.37	0.15	23.4	0.5
4/19/2007	Former Trifolium 20	FT20	B	47.8	24.3	7.36			
4/19/2007	Former Trifolium 20	FT20	C	37.5	24.0	7.17			
4/19/2007	Former Trifolium 20	FT20	D	83.2	24.5	7.26			
4/19/2007	Former Trifolium 20	FT20	E	-23.6	21.8	7.22			

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Location	Eh (mV)	Temp (°C)	pH	Se (µg/g dry weight)	Moisture (%)	TOC (%)
4/20/2007	Trifolium 20	TR20	A	-411	15.4	7.07	2.03	60.7	2.0
4/20/2007	Trifolium 20	TR20	B	-417	15.3	7.32			
4/20/2007	Trifolium 20	TR20	C	-281	15.4	7.47			
4/20/2007	Trifolium 20	TR20	D	-208	15.0	7.34			
4/20/2007	Trifolium 20	TR20	E	-412	15.5	7.14			
4/20/2007	Trifolium 19	TR19	A	-150	15.2	6.82	0.65	31.1	1.0
4/20/2007	Trifolium 19	TR19	B	-192.8	15.2	6.86			
4/20/2007	Trifolium 19	TR19	C	-212	15.4	7.06			
4/20/2007	Trifolium 19	TR19	D	-367	16.5	7.05			
4/20/2007	Trifolium 19	TR19	E	-196.4	17.3	6.94			
4/17/2007	Poe	POED	A	234	14.4	7.99	0.57	32.5	1.0
4/17/2007	Poe	POED	B	-111	15.1	7.53			
4/17/2007	Poe	POED	C	63.7	18.4	7.43			
4/17/2007	Poe	POED	D	68.9	20.1	7.45			
4/17/2007	Poe	POED	E	37	21.6	7.44			
4/20/2007	Trifolium 18	TR18	A	-399	18.5	6.68	7.02	55.3	2.1
4/20/2007	Trifolium 18	TR18	B	-369	17.9	6.58			
4/20/2007	Trifolium 18	TR18	C	-406	18.3	6.80			
4/20/2007	Trifolium 18	TR18	D	-413	18.2	6.89			
4/20/2007	Trifolium 18	TR18	E	-414	18.1	7.34			
4/26/2007	Trifolium Storm	TRST	A	-365	17.6	7.11	0.51	37.5	0.6
4/26/2007	Trifolium Storm	TRST	B	-318	17.9	7.32			
4/26/2007	Trifolium Storm	TRST	C	-337	19.2	7.40			
4/26/2007	Trifolium Storm	TRST	D	-354	18.9	7.28			
4/26/2007	Trifolium Storm	TRST	E	-327	19.7	7.03			
4/26/2007	Trifolium 1	TR01	A	-228	21.3	7.34	1.15	47.6	1.4
4/26/2007	Trifolium 1	TR01	B	-257	19.7	6.64			
4/26/2007	Trifolium 1	TR01	C	-259	20.1	6.68			
4/26/2007	Trifolium 1	TR01	D	-208	19.7	6.71			
4/26/2007	Trifolium 1	TR01	E	-78.6	19.5	6.93			
4/21/2007	Trifolium 14A	TR14	A	-204	16.2	7.14	1.33	39.5	1.4
4/21/2007	Trifolium 14A	TR14	B	-202	17.7	7.57			

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Location	Eh (mV)	Temp (°C)	pH	Se (µg/g dry weight)	Moisture (%)	TOC (%)
4/21/2007	Trifolium 14A	TR14	C	-206	16.8	7.29			
4/21/2007	Trifolium 14A	TR14	D	-202	16.2	7.22			
4/21/2007	Trifolium 14A	TR14	E	-180.7	17.8	7.62			
4/21/2007	Trifolium 13	TR13	A	-179.8	12.9	7.18	1.82	55.1	3.0
4/21/2007	Trifolium 13	TR13	B	-391	12.9	7.20			
4/21/2007	Trifolium 13	TR13	C	-121.6	14.0	7.28			
4/21/2007	Trifolium 13	TR13	D	-74.9	13.7	7.29			
4/21/2007	Trifolium 13	TR13	E	-11.1	14.6	7.33			
4/26/2007	Trifolium 12	TR12	A	147.9	24.6	7.46	0.23	23.2	0.3
4/26/2007	Trifolium 12	TR12	B	-90	26.3	6.99			
4/26/2007	Trifolium 12	TR12	C	-194.8	25.1	6.87			
4/26/2007	Trifolium 12	TR12	D	-194.2	27.2	7.15			
4/26/2007	Trifolium 12	TR12	E	-24	27.4	7.27			
4/26/2007	Vail 5 Pond	VL05	A	-175	17.2	7.47	6.04	75.8	3.6
4/26/2007	Vail 5 Pond	VL05	B	-385	18.8	7.34			
4/26/2007	Vail 5 Pond	VL05	C	-391	19.3	7.24			
4/26/2007	Vail 5 Pond	VL05	D	-404	19.8	7.08			
4/26/2007	Vail 5 Pond	VL05	E	-409	20.2	6.94			
4/20/2007	Lack & Lindsey Pond	LKLN	A	-59.4	20.3	7.83	1.58	51.1	3.3
4/20/2007	Lack & Lindsey Pond	LKLN	B	-49.2	19.8	7.08			
4/20/2007	Lack & Lindsey Pond	LKLN	C	-131.7	20.0	7.72			
4/20/2007	Lack & Lindsey Pond	LKLN	D	-186.6	20.7	7.53			
4/20/2007	Lack & Lindsey Pond	LKLN	E	-354	20.0	7.30			
4/21/2007	Pumice Pond	PUMC	A	-194.6	19.8	7.03	1.03	47.4	1.5
4/21/2007	Pumice Pond	PUMC	B	-21.2	19.5	7.29			
4/21/2007	Pumice Pond	PUMC	C	-122.4	19.4	6.99			
4/21/2007	Pumice Pond	PUMC	D	-138.3	20.6	6.99			
4/21/2007	Pumice Pond	PUMC	E	-47.1	19.2	7.12			
4/28/2007	O	OOOO	A	-232	17.9	7.35	0.87	48.2	0.6
4/28/2007	O	OOOO	B	-180.7	19.6	7.20			
4/28/2007	O	OOOO	C	-222	21.3	7.22			
4/28/2007	O	OOOO	D	-279	20.9	7.22			

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Location	Eh (mV)	Temp (°C)	pH	Se (µg/g dry weight)	Moisture (%)	TOC (%)
4/28/2007	O	OOOO	E	-247	21.6	6.99			
4/27/2007	P	PPPP	A	-203	18.6	7.45	1.05	50.0	2.3
4/27/2007	P	PPPP	B	-256	18.4	7.38			
4/27/2007	P	PPPP	C	-246	18.3	7.35			
4/27/2007	P	PPPP	D	-222	18.8	7.38			
4/27/2007	P	PPPP	E	-370	19.2	7.22			
4/27/2007	Q	QQQQ	A	-39.9	18.3	7.70	1.17	48.3	0.6
4/27/2007	Q	QQQQ	B	11.6	18.2	7.43			
4/27/2007	Q	QQQQ	C	-163.9	19.6	7.35			
4/27/2007	Q	QQQQ	D	-137.4	19.7	7.40			
4/27/2007	Q	QQQQ	E	-65.1	20.6	7.66			
4/27/2007	R	RRRR	A	-230	22.1	7.59	0.38	26.1	0.5
4/27/2007	R	RRRR	B	-245	21.8	7.12			
4/27/2007	R	RRRR	C	-171.5	21.6	7.07			
4/27/2007	R	RRRR	D	-220	23.0	7.37			
4/27/2007	R	RRRR	E	-321	22.6	7.23			
4/27/2007	S	SSSS	A	-233	24.6	7.13	0.89	49.2	1.9
4/27/2007	S	SSSS	B	-226	23.6	6.90			
4/27/2007	S	SSSS	C	-236	23.2	7.13			
4/27/2007	S	SSSS	D	-236	24.3	7.01			
4/27/2007	S	SSSS	E	-210.6	25.3	7.16			
4/27/2007	T	TTTT	A	-353	25.3	7.21	0.79	50.4	0.8
4/27/2007	T	TTTT	B	-290	26.3	7.14			
4/27/2007	T	TTTT	C	-198.7	26.6	7.14			
4/27/2007	T	TTTT	D	-279	26.7	7.20			
4/27/2007	T	TTTT	E	-325	26.8	7.21			
4/24/2007	U	UUUU	A	-202	23.6	7.33	1.25	58.2	1.5
4/24/2007	U	UUUU	B	-239	22.4	7.21			
4/24/2007	U	UUUU	C	-208	22.6	7.29			
4/24/2007	U	UUUU	D	-202	22.7	7.07			
4/24/2007	U	UUUU	E	-218	23.1	7.01			
4/24/2007	W	WWWW	A	-204	22.4	7.22	0.62	44.8	0.8

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Location	Eh (mV)	Temp (°C)	pH	Se (µg/g dry weight)	Moisture (%)	TOC (%)
4/24/2007	W	WWWW	B	-204	21.8	6.88			
4/24/2007	W	WWWW	C	-204	22.9	6.98			
4/24/2007	W	WWWW	D	-181.3	21.5	6.78			
4/24/2007	W	WWWW	E	-204	21.1	6.65			
4/23/2007	Z Spill	ZSPL	A	-214	14.8	7.02	1.42	60.3	1.9
4/23/2007	Z Spill	ZSPL	B	-232	14.3	7.08			
4/23/2007	Z Spill	ZSPL	C	-339	14.7	7.25			
4/23/2007	Z Spill	ZSPL	D	-329	16.3	6.76			
4/23/2007	Z Spill	ZSPL	E	-236	15.7	6.78			
4/23/2007	Niland 1	NLD1	A	-335	17.7	7.15	1.14	53.6	1.5
4/23/2007	Niland 1	NLD1	B	-262	18.7	7.01			
4/23/2007	Niland 1	NLD1	C	-368	18.7	7.07			
4/23/2007	Niland 1	NLD1	D	-392	19.2	7.02			
4/23/2007	Niland 1	NLD1	E	-242	18.5	7.03			
4/24/2007	Niland 2	NLD2	A	-199.1	21.1	7.22	1.15	52.7	1.3
4/24/2007	Niland 2	NLD2	B	-186.4	24.7	7.01			
4/24/2007	Niland 2	NLD2	C	-189.6	22.4	6.86			
4/24/2007	Niland 2	NLD2	D	-210	21.0	6.98			
4/24/2007	Niland 2	NLD2	E	-240	22.4	6.95			
4/24/2007	Niland 3	NLD3	A	-202	17.5	7.28	0.76	50.4	0.8
4/24/2007	Niland 3	NLD3	B	-198.9	17.7	7.11			
4/24/2007	Niland 3	NLD3	C	-206	18.2	7.01			
4/24/2007	Niland 3	NLD3	D	-206	18.8	7.02			
4/24/2007	Niland 3	NLD3	E	-204	19.5	7.12			
4/24/2007	Niland 4	NLD4	A	-368	15.2	7.08	1.24	51.4	3.5
4/24/2007	Niland 4	NLD4	B	-330	15.7	6.86			
4/24/2007	Niland 4	NLD4	C	-285	15.4	6.90			
4/24/2007	Niland 4	NLD4	D	-279	15.9	6.81			
4/24/2007	Niland 4	NLD4	E	-271	17.9	6.74			
10/11/2007	Trifolium 20	TR20	A	-187	17.6	7.00	1.39	52.2	0.6
10/11/2007	Trifolium 20	TR20	B	-331	17.3	6.69			
10/11/2007	Trifolium 20	TR20	C	-309	18.4	6.95			

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Location	Eh (mV)	Temp (°C)	pH	Se (µg/g dry weight)	Moisture (%)	TOC (%)
10/11/2007	Trifolium 20	TR20	D	-301	18.8	7.27			
10/11/2007	Trifolium 20	TR20	E	-201	19.8	6.89			
10/11/2007	Poe	POED	A	-194.7	25.4	6.68	0.33	23.6	0.5
10/11/2007	Poe	POED	B	6.8	25.3	7.11			
10/11/2007	Poe	POED	C	73.3	24.8	7.07			
10/11/2007	Poe	POED	D	79.3	25.9	7.09			
10/11/2007	Poe	POED	E	84.7	25.4	7.08			
10/12/2007	Trifolium 18	TR18	A	-407	18.6	7.09	7.28	59.3	1.0
10/12/2007	Trifolium 18	TR18	B	-378	18.8	7.14			
10/12/2007	Trifolium 18	TR18	C	-390	18.6	7.13			
10/12/2007	Trifolium 18	TR18	D	-404	18.8	7.05			
10/12/2007	Trifolium 18	TR18	E	-394	18.0	7.04			
10/15/2007	Trifolium 14A	TR14	A	-390	27.3	7.00	2.40	56.0	1.7
10/15/2007	Trifolium 14A	TR14	B	-377	26.6	7.06			
10/15/2007	Trifolium 14A	TR14	C	-348	27.0	7.43			
10/15/2007	Trifolium 14A	TR14	D	-388	27.4	7.01			
10/15/2007	Trifolium 14A	TR14	E	-389	27.6	6.97			
10/14/2007	O	OOOO	A	-251	17.6	7.08	0.97	48.6	0.0
10/14/2007	O	OOOO	B	-289	17.9	7.46			
10/14/2007	O	OOOO	C	-317	19.9	6.64			
10/14/2007	O	OOOO	D	-242	19.0	6.77			
10/14/2007	O	OOOO	E	-333	19.2	7.36			
10/14/2007	T	TTTT	A	-278	23.4	7.29	0.47	40.0	1.0
10/14/2007	T	TTTT	B	-316	22.6	7.20			
10/14/2007	T	TTTT	C	-313	22.4	7.23			
10/14/2007	T	TTTT	D	-216	22.6	7.21			
10/14/2007	T	TTTT	E	-277	22.7	7.23			
10/16/2007	Z Spill	ZSPL	A	-380	20.1	7.10	1.44	55.9	0.2
10/16/2007	Z Spill	ZSPL	B	-393	20.7	7.22			
10/16/2007	Z Spill	ZSPL	C	-396	21.0	7.10			
10/16/2007	Z Spill	ZSPL	D	-331	21.9	7.30			
10/16/2007	Z Spill	ZSPL	E	-369	21.4	6.91			

Table A3. Raw data for measurements of particle size distribution of sediment in 29 drains or ponds during April 2007 and in seven drains during October 2007.

[Values for particle size categories are percentages. **Abbreviations**: mm/dd/yyyy, month/day/year; ID, identification code; <2mm, less than 2 millimeters]

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Particle size category			
			<2mm	sand	silt	Clay
4/19/2007	Trifolium 23	TR23	18.0	40.8	22.7	18.5
4/19/2007	San Felipe Wash	SFWH	0.57	68.5	18.1	12.8
4/19/2007	Trifolium 22	TR22	3.42	33.2	41.1	22.3
4/19/2007	Former Trifolium 20	FT20	0.02	78.3	11.0	10.7
4/20/2007	Trifolium 20	TR20	0.74	32.1	42.2	24.9
4/20/2007	Trifolium 19	TR19	1.24	63.9	22.3	12.5
4/17/2007	Poe	POED	1.29	63.4	19.0	16.3
4/20/2007	Trifolium 18	TR18	0.30	64.7	28.3	6.68
4/26/2007	Trifolium Storm	TRST	0.02	53.0	26.5	20.5
4/26/2007	Trifolium 1	TR01	0.12	27.1	32.5	40.3
4/21/2007	Trifolium 14A	TR14	3.27	29.7	37.2	29.9
4/21/2007	Trifolium 13	TR13	5.56	41.5	34.4	18.6
4/26/2007	Trifolium 12	TR12	0.03	58.2	26.9	14.9
4/26/2007	Lack & Lindsey Pond	VL05	0.42	39.2	53.1	7.23
4/20/2007	Vail 5 Pond	LKLN	13.7	46.9	29.2	10.2
4/21/2007	Pumice Pond	PUMC	2.89	21.8	43.3	32.0
4/28/2007	O	OOOO	0.08	21.3	35.2	43.4
4/27/2007	P	PPPP	0.59	19.1	37.0	43.3
4/27/2007	Q	QQQQ	0.11	11.5	36.2	52.3
4/27/2007	R	RRRR	4.55	54.0	17.4	24.2
4/27/2007	S	SSSS	15.4	24.4	30.2	30.0
4/27/2007	T	TTTT	0.40	32.3	29.0	38.2
4/24/2007	U	UUUU	2.94	15.3	31.5	50.3
4/24/2007	W	WWWW	0.86	13.7	42.6	42.9
4/23/2007	Z Spill	ZSPL	1.58	34.3	39.6	24.5
4/23/2007	Niland 1	NLD1	0.59	9.29	39.4	50.7
4/24/2007	Niland 2	NLD2	0.55	12.9	43.2	43.4
4/24/2007	Niland 3	NLD3	1.71	12.1	32.2	53.9
4/24/2007	Niland 4	NLD4	0.59	21.3	24.7	53.5
10/11/2007	Trifolium 20	TR20	0.16	26.3	36.9	36.6
10/11/2007	Poe	POED	0.17	64.5	17.8	17.5
10/12/2007	Trifolium 18	TR18	0.13	60.7	30.2	9.0
10/15/2007	Trifolium 14	TR14	0.74	20.6	53.3	25.3
10/14/2007	O	OOOO	0.64	20.8	36.9	41.6
10/14/2007	T	TTTT	0.50	34.7	33.6	31.3
10/16/2007	Z Spill	ZSPL	0.58	19.6	44.4	35.4

Table A4. Raw catch statistics for minnow traps fished in 29 drains or ponds during April 2007, October 2007, and January 2008.

[Traps were not fished in July 2007 because we lacked an incidental take permit for desert pupfish from the California Department of Fish and Game. Each observation represents the combined catch from 10 baited traps fished for 60 minutes. **Abbreviations**: mm/dd/yyyy, month/day/year; ID, identification code; GMB, western mosquitofish; SLM, sailfin molly; RT, redbelly tilapia; MT, hybrid Mozambique tilapia; RSH, red shiner; DP, desert pupfish; BG, bluegill; Carp, common carp; Shrimp, freshwater shrimp]

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Numbers of fish or shrimp								
			GMB	SLM	RT	MT	RSH	DP	BG	Carp	Shrimp
4/19/2007	Trifolium 23	TR23	0	0	0	0	0	0	0	0	0
4/19/2007	San Felipe Wash	SFWH	1	0	0	0	0	0	0	0	0
4/19/2007	Trifolium 22	TR22	0	0	0	0	0	0	0	0	0
4/19/2007	Former Trifolium 20	FT20	6	0	0	0	1	43	0	0	0
4/20/2007	Trifolium 20	TR20	5	0	0	0	2	0	0	0	0
4/20/2007	Trifolium 19	TR19	0	0	0	0	0	0	0	0	0
4/17/2007	Poe	POED	0	0	0	0	0	0	0	0	0
4/20/2007	Trifolium 18	TR18	0	0	0	0	0	0	0	0	0
4/26/2007	Trifolium Storm	TRST	0	0	0	0	0	0	0	0	1
4/26/2007	Trifolium 1	TR01	2	0	0	0	0	0	0	0	0
4/21/2007	Trifolium 14A	TR14	27	1	0	0	0	2	0	0	22
4/21/2007	Trifolium 13	TR13	0	0	0	0	0	0	0	0	0
4/26/2007	Trifolium 12	TR12	0	0	0	0	0	0	0	0	0
4/26/2007	Lack & Lindsey Pond	VL05	0	0	0	0	0	0	0	0	0
4/20/2007	Vail 5 Pond	LKLN	0	0	0	0	0	1	0	0	0
4/21/2007	Pumice Pond	PUMC	0	0	0	0	1	0	0	0	0
4/28/2007	O	OOOO	1	0	0	0	1	0	0	0	2
4/27/2007	P	PPPP	0	0	0	0	0	0	0	0	2
4/27/2007	Q	QQQQ	0	0	0	0	0	0	0	0	0

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Numbers of fish or shrimp								
			GMB	SLM	RT	MT	RSH	DP	BG	Carp	Shrimp
4/27/2007	R	RRRR	0	0	0	0	0	0	1	0	2
4/27/2007	S	SSSS	0	0	0	0	0	0	0	0	15
4/27/2007	T	TTTT	97	0	0	0	0	0	0	0	725
4/24/2007	U	UUUU	0	1	0	0	5	0	0	0	2
4/24/2007	W	WWWW	0	0	0	0	7	0	0	0	0
4/23/2007	Z Spill	ZSPL	0	0	0	0	0	0	0	0	0
4/23/2007	Niland 1	NLD1	1	0	0	0	0	0	0	0	11
4/24/2007	Niland 2	NLD2	12	0	0	0	23	0	0	1	5
4/24/2007	Niland 3	NLD3	4	0	0	0	0	0	0	0	17
4/24/2007	Niland 4	NLD4	0	0	0	0	0	0	0	0	0
10/15/2007	Trifolium 23	TR23	4	0	0	0	247	0	0	0	0
10/15/2007	San Felipe Wash	SFWH	0	0	0	0	0	0	0	0	0
10/15/2007	Trifolium 22	TR22	0	0	0	0	0	0	0	0	0
10/15/2007	Former Trifolium 20	FT20	59	12	0	32	0	0	0	0	0
10/11/2007	Trifolium 20	TR20	130	0	0	6	2	0	0	0	0
10/11/2007	Trifolium 19	TR19	3106	12	0	0	0	0	0	0	0
10/11/2007	Poe	POED	0	0	0	25	0	0	0	0	0
10/12/2007	Trifolium 18	TR18	68	54	0	31	0	1	0	0	0
10/12/2007	Trifolium Storm	TRST	6	0	0	0	0	0	0	0	0
10/12/2007	Trifolium 1	TR01	10	0	0	0	0	0	0	0	0
10/15/2007	Trifolium 14A	TR14	0	29	0	2	0	133	0	0	0
10/15/2007	Trifolium 13	TR13	12	0	0	0	0	0	0	0	0
10/12/2007	Trifolium 12	TR12	0	1	0	0	0	0	0	0	0
10/11/2007	Lack & Lindsey Pond	VL05	0	0	0	0	0	0	2	0	0
10/12/2007	Vail 5 Pond	LKLN	0	5	0	0	0	0	0	0	0
10/11/2007	Pumice Pond	PUMC	1	1	0	0	0	0	0	0	0
10/14/2007	O	OOOO	59	8	0	0	0	0	0	0	0
10/14/2007	P	PPPP	10	1	0	0	113	0	0	0	1
10/14/2007	Q	QQQQ	0	0	0	0	0	0	0	0	0
10/14/2007	R	RRRR	1	0	0	0	0	0	0	0	0
10/14/2007	S	SSSS	0	0	0	0	0	0	0	0	0
10/14/2007	T	TTTT	230	133	0	0	0	0	0	0	142

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Numbers of fish or shrimp								
			GMB	SLM	RT	MT	RSH	DP	BG	Carp	Shrimp
10/14/2007	U	UUUU	2	2	0	2	0	0	0	0	9
10/14/2007	W	WWWW	16	0	0	0	0	0	0	0	0
10/16/2007	Z Spill	ZSPL	0	0	1	0	1	0	0	0	0
10/16/2007	Niland 1	NLD1	87	13	0	0	0	0	0	0	0
10/16/2007	Niland 2	NLD2	10	4	0	0	0	0	0	0	3
10/16/2007	Niland 3	NLD3	1	0	0	0	0	0	0	0	1
10/16/2007	Niland 4	NLD4	0	0	0	0	0	0	0	0	0
1/10/2008	Trifolium 23	TR23	0	0	0	0	2	0	0	0	0
1/10/2008	San Felipe Wash	SFWH	0	0	0	0	0	0	1	0	0
1/10/2008	Trifolium 22	TR22	0	0	0	0	0	0	0	0	0
1/10/2008	Former Trifolium 20	FT20	0	0	0	0	0	0	0	0	0
1/10/2008	Trifolium 20	TR20	0	0	0	0	0	0	0	0	0
1/10/2008	Trifolium 19	TR19	1292	2	0	0	0	0	0	0	0
1/10/2008	Poe	POED	1	0	0	0	0	0	0	0	0
1/10/2008	Trifolium 18	TR18	0	0	0	0	0	0	0	0	0
1/15/2008	Trifolium Storm	TRST	0	0	0	0	0	0	0	0	0
1/15/2008	Trifolium 1	TR01	0	0	0	0	0	0	0	0	0
1/11/2008	Trifolium 14A	TR14	0	0	0	0	0	0	0	0	0
1/11/2008	Trifolium 13	TR13	0	0	0	0	0	1	0	0	0
1/11/2008	Trifolium 12	TR12	0	1	0	0	0	0	0	0	0
1/12/2008	Lack & Lindsey Pond	VL05	0	0	0	0	0	0	0	0	4
1/11/2008	Vail 5 Pond	LKLN	0	0	0	0	0	0	0	0	0
1/12/2008	Pumice Pond	PUMC	0	0	0	0	0	1	0	0	0
1/12/2008	O	OOOO	0	0	0	0	0	0	0	0	0
1/12/2008	P	PPPP	0	0	0	0	16	0	0	0	0
1/12/2008	Q	QQQQ	0	0	0	0	2	0	0	0	0
1/12/2008	R	RRRR	0	0	0	0	0	0	0	0	3
1/12/2008	S	SSSS	0	0	0	0	0	0	0	0	0
1/12/2008	T	TTTT	0	1	0	0	0	0	0	0	46
1/12/2008	U	UUUU	0	0	0	0	0	0	0	0	0
1/12/2008	W	WWWW	0	0	0	0	0	0	0	0	0
1/12/2008	Z Spill	ZSPL	0	0	0	0	0	0	0	0	0

Date (mm/dd/yyyy)	Drain or pond	Drain or pond ID	Numbers of fish or shrimp								
			GMB	SLM	RT	MT	RSH	DP	BG	Carp	Shrimp
1/14/2008	Niland 1	NLD1	0	0	0	0	0	0	0	0	0
1/14/2008	Niland 2	NLD2	0	0	0	0	0	0	0	0	0
1/14/2008	Niland 3	NLD3	0	1	0	0	0	0	0	0	0
1/14/2008	Niland 4	NLD4	0	0	0	0	0	0	1	0	0

Table A5. Raw data for selenium speciation from seven intensively sampled drains during April and October 2007 sampling. All concentrations are µg/L.

[**Calculated dissolved selenate $[SeO_4]^{-2}$**: computed as (dissolved mixture of selenate+selenite)-dissolved selenite. **Calculated dissolved organic Se**: computed as total dissolved selenium-(dissolved mixture of selenate+selenite). **Calculated total Se**: computed as total dissolved selenium+particulate selenium.

Abbreviations: µg/L, micrograms per liter; mm/dd/yyyy, month/day/year; ID, identification code; Rep #, Replication number; Se, selenium]

Date (mm/dd/yyyy)	Drain	Drain ID	Rep #	Measured dissolved selenite $[SeO_3]^{-2}$	Calculated dissolved selenate $[SeO_4]^{-2}$	Calculated dissolved organic Se	Measured total dissolved Se	Measured particulate Se	Calculated total Se
4/20/2007	Trifolium 20	TR20	1	0.74	3.70	1.34	5.78	0.075	5.85
4/20/2007	Trifolium 20	TR20	2	0.77	3.78	1.40	5.95	0.077	6.03
4/17/2007	Poe	POED	1	0.50	7.80	0.98	9.23	0.019	9.20
4/17/2007	Poe	POED	2	0.50	7.40	1.81	9.72	0.015	9.70
4/20/2007	Trifolium 18	TR18	1	1.12	22.3	0.37	23.7	0.130	23.9
4/20/2007	Trifolium 18	TR18	2	1.10	22.4	0.56	24.1	0.091	24.2
4/21/2007	Trifolium 14A	TR14	1	0.36	1.94	0.01	2.20	0.067	2.26
4/21/2007	Trifolium 14A	TR14	2	0.39	1.47	0.29	2.14	0.066	2.20
4/28/2007	O	OOOO	1	0.49	3.27	0.24	4.00	0.100	4.10
4/28/2007	O	OOOO	2	0.48	3.41	0.21	4.10	0.110	4.22
4/27/2007	T	TTTT	1	0.16	1.67	0.01	1.04	0.030	1.07
4/27/2007	T	TTTT	2	0.16	0.70	0.23	1.10	0.032	1.13
4/23/2007	Z Spill	ZSPL	1	0.51	2.56	0.17	3.23	0.039	3.27
4/23/2007	Z Spill	ZSPL	2	0.56	2.43	0.17	3.15	0.038	3.19
10/11/2007	Trifolium 20	TR20	1	0.23	3.34	0.51	4.08	0.080	4.16

Date (mm/dd/yyyy)	Drain	Drain ID	Rep #	Measured dissolved selenite $[SeO_3]^{-2}$	Calculated dissolved selenate $[SeO_4]^{-2}$	Calculated dissolved organic Se	Measured total dissolved Se	Measured particulate Se	Calculated total Se
10/11/2007	Trifolium 20	TR20	2	0.23	3.05	0.98	4.26	0.092	4.35
10/11/2007	Poe	POED	1	0.20	4.60	0.80	5.60	0.025	5.60
10/11/2007	Poe	POED	2	0.18	4.40	0.71	5.31	0.020	5.30
10/12/2007	Trifolium 18	TR18	1	2.34	14.9	0.01	16.5	0.086	16.6
10/12/2007	Trifolium 18	TR18	2	2.28	14.1	0.53	16.9	0.100	17.0
10/15/2007	Trifolium 14A	TR14	1	0.46	16.24	1.67	18.37	0.029	18.39
10/15/2007	Trifolium 14A	TR14	2	0.46	15.84	2.97	19.27	0.039	19.3
10/14/2007	O	OOOO	1	0.85	7.75	0.99	9.59	0.130	9.72
10/14/2007	O	OOOO	2	0.89	8.31	0.44	9.64	0.150	9.79
10/14/2007	T	TTTT	1	0.13	0.40	0.17	0.70	0.014	0.72
10/14/2007	T	TTTT	2	0.19	0.35	0.30	0.84	0.019	0.86
10/16/2007	Z Spill	ZSPL	1	0.77	3.09	0.52	4.38	0.110	4.49
10/16/2007	Z Spill	ZSPL	2	0.79	3.02	0.61	4.42	0.120	4.54

Table A6. Raw data for measurements of total selenium and moisture content in selected aquatic food-chain matrices collected from seven intensively sampled drains in April 2007 and October 2007.

[Abbreviations or acronyms for the matrices are: DET, particulate organic detritus; ALG, filamentous algae; NPT, net plankton; and CHI, midge larvae. mm/yyyy, month/year; ID, identification code; Rep #, Replication number, %, percent; µg/g, micrograms per gram]

Date (mm/yyyy)	Drain or pond	Drain or pond ID	Matrix	Rep #	Moisture (%)	Se (µg/g dry weight)
APR07	Trifolium 20	TR20	ALG	1	78.2	1.33
APR07	Trifolium 20	TR20	ALG	2	60.6	2.01
APR07	Trifolium 20	TR20	ALG	3	63.5	1.75
APR07	Poe	POED	ALG	1	75.3	1.07
APR07	Poe	POED	ALG	2	78.3	1.03
APR07	Poe	POED	ALG	3	81.8	0.88
APR07	Trifolium 18	TR18	ALG	1	81.9	5.63
APR07	Trifolium 18	TR18	ALG	2	82.4	5.74
APR07	Trifolium 18	TR18	ALG	3	83.4	5.41
APR07	Trifolium 14A	TR14	ALG	1	75.7	2.40
APR07	Trifolium 14A	TR14	ALG	2	73.2	2.19
APR07	Trifolium 14A	TR14	ALG	3	72.7	2.48
APR07	O	OOOO	ALG	1	68.3	1.99
APR07	O	OOOO	ALG	2	67.3	1.67
APR07	O	OOOO	ALG	3	71.4	1.57
APR07	T	TTTT	ALG	1	71.6	1.97
APR07	T	TTTT	ALG	2	69.6	2.63
APR07	T	TTTT	ALG	3	68.9	2.50
APR07	Z Spill	ZSPL	ALG	1	64.3	1.56
APR07	Z Spill	ZSPL	ALG	2	70.1	1.53
APR07	Z Spill	ZSPL	ALG	3	69.7	1.45
APR07	Trifolium 20	TR20	NPT	1	.	3.34
APR07	Trifolium 20	TR20	NPT	2	.	2.55
APR07	Trifolium 20	TR20	NPT	3	.	2.41
APR07	Poe	POED	NPT	1	.	1.45
APR07	Poe	POED	NPT	2	.	2.04
APR07	Poe	POED	NPT	3	.	2.08
APR07	Trifolium 18	TR18	NPT	1	.	15.5
APR07	Trifolium 18	TR18	NPT	2	.	17.0
APR07	Trifolium 18	TR18	NPT	3	.	11.9
APR07	Trifolium 14A	TR14	NPT	1	.	4.27
APR07	Trifolium 14A	TR14	NPT	2	.	4.32

Date (mm/yyyy)	Drain or pond	Drain or pond ID	Matrix	Rep #	Moisture (%)	Se (µg/g dry weight)
APR07	Trifolium 14A	TR14	NPT	3	.	4.41
APR07	O	OOOO	NPT	1	.	1.97
APR07	O	OOOO	NPT	2	.	2.05
APR07	O	OOOO	NPT	3	.	2.29
APR07	T	TTTT	NPT	1	.	4.80
APR07	T	TTTT	NPT	2	.	1.52
APR07	T	TTTT	NPT	3	.	1.40
APR07	Z Spill	ZSPL	NPT	1	.	2.08
APR07	Z Spill	ZSPL	NPT	2	.	2.75
APR07	Z Spill	ZSPL	NPT	3	.	3.41
APR07	Trifolium 20	TR20	CHI	1	84.4	9.29
APR07	Trifolium 20	TR20	CHI	2	84.3	8.52
APR07	Trifolium 20	TR20	CHI	3	84.0	8.29
APR07	Poe	POED	CHI	1	75.8	4.76
APR07	Poe	POED	CHI	2	71.3	3.69
APR07	Poe	POED	CHI	3	74.6	4.53
APR07	Trifolium 18	TR18	CHI	1	84.1	12.7
APR07	Trifolium 18	TR18	CHI	2	87.9	13.4
APR07	Trifolium 18	TR18	CHI	3	87.0	13.2
APR07	Trifolium 14A	TR14	CHI	1	82.7	7.42
APR07	Trifolium 14A	TR14	CHI	2	80.8	6.86
APR07	Trifolium 14A	TR14	CHI	3	82.5	7.25
APR07	O	OOOO	CHI	1	81.8	4.36
APR07	O	OOOO	CHI	2	82.2	3.76
APR07	O	OOOO	CHI	3	83.1	4.79
APR07	T	TTTT	CHI	1	83.8	5.39
APR07	T	TTTT	CHI	2	83.8	4.58
APR07	T	TTTT	CHI	3	83.9	5.21
APR07	Z Spill	ZSPL	CHI	1	78.6	3.56
APR07	Z Spill	ZSPL	CHI	2	81.9	3.18
APR07	Z Spill	ZSPL	CHI	3	81.6	3.43
APR07	Trifolium 20	TR20	DET	1	74.4	9.42
APR07	Trifolium 20	TR20	DET	2	77.5	7.87
APR07	Trifolium 20	TR20	DET	3	75.0	7.41
APR07	Poe	POED	DET	1	66.8	11.7
APR07	Poe	POED	DET	2	67.7	8.4
APR07	Poe	POED	DET	3	69.6	11.1
APR07	Trifolium 18	TR18	DET	1	79.8	26.5
APR07	Trifolium 18	TR18	DET	2	81.2	23.6
APR07	Trifolium 18	TR18	DET	3	81.9	28.9
APR07	Trifolium 14A	TR14	DET	1	77.7	6.98
APR07	Trifolium 14A	TR14	DET	2	77.3	6.41
APR07	Trifolium 14A	TR14	DET	3	79.9	6.55
APR07	O	OOOO	DET	1	78.0	4.86
APR07	O	OOOO	DET	2	79.4	9.27
APR07	O	OOOO	DET	3	76.2	9.43
APR07	T	TTTT	DET	1	77.1	2.71
APR07	T	TTTT	DET	2	77.2	2.64

Date (mm/yyyy)	Drain or pond	Drain or pond ID	Matrix	Rep #	Moisture (%)	Se (µg/g dry weight)
APR07	T	TTTT	DET	3	76.4	2.66
APR07	Z Spill	ZSPL	DET	1	80.4	5.40
APR07	Z Spill	ZSPL	DET	2	81.6	4.29
APR07	Z Spill	ZSPL	DET	3	81.2	3.16
OCT07	Trifolium 20	TR20	ALG	1	60.4	2.44
OCT07	Trifolium 20	TR20	ALG	2	60.5	2.47
OCT07	Trifolium 20	TR20	ALG	3	59.7	2.53
OCT07	Poe	POED	ALG	1	54.6	1.35
OCT07	Poe	POED	ALG	2	54.7	1.32
OCT07	Poe	POED	ALG	3	55.0	1.32
OCT07	Trifolium 18	TR18	ALG	1	63.4	5.99
OCT07	Trifolium 18	TR18	ALG	2	63.3	5.73
OCT07	Trifolium 18	TR18	ALG	3	62.9	5.84
OCT07	Trifolium 14A	TR14	ALG	1	66.2	3.31
OCT07	Trifolium 14A	TR14	ALG	2	69.4	3.28
OCT07	Trifolium 14A	TR14	ALG	3	66.9	3.32
OCT07	O	OOOO	ALG	1	56.9	3.16
OCT07	O	OOOO	ALG	2	55.1	3.22
OCT07	O	OOOO	ALG	3	55.3	3.16
OCT07	T	TTTT	ALG	1	65.1	0.97
OCT07	T	TTTT	ALG	2	64.8	0.96
OCT07	T	TTTT	ALG	3	64.9	0.95
OCT07	Z Spill	ZSPL	ALG	1	60.0	3.88
OCT07	Z Spill	ZSPL	ALG	2	61.1	3.69
OCT07	Z Spill	ZSPL	ALG	3	62.5	3.75
OCT07	Trifolium 20	TR20	NPT	1	.	1.56
OCT07	Trifolium 20	TR20	NPT	2	.	2.23
OCT07	Trifolium 20	TR20	NPT	3	.	2.00
OCT07	Poe	POED	NPT	1	.	0.21
OCT07	Poe	POED	NPT	2	.	0.15
OCT07	Poe	POED	NPT	3	.	0.15
OCT07	Trifolium 18	TR18	NPT	1	.	12.90
OCT07	Trifolium 18	TR18	NPT	2	.	17.90
OCT07	Trifolium 18	TR18	NPT	3	.	19.30
OCT07	Trifolium 14A	TR14	NPT	1	.	4.54
OCT07	Trifolium 14A	TR14	NPT	2	.	4.04
OCT07	Trifolium 14A	TR14	NPT	3	.	2.88
OCT07	O	OOOO	NPT	1	.	2.58
OCT07	O	OOOO	NPT	2	.	2.90
OCT07	O	OOOO	NPT	3	.	3.05
OCT07	T	TTTT	NPT	1	.	1.05
OCT07	T	TTTT	NPT	2	.	0.59
OCT07	T	TTTT	NPT	3	.	0.55
OCT07	Z Spill	ZSPL	NPT	1	.	1.47
OCT07	Z Spill	ZSPL	NPT	2	.	0.84
OCT07	Z Spill	ZSPL	NPT	3	.	0.39
OCT07	Trifolium 20	TR20	CHI	1	74.9	2.21
OCT07	Trifolium 20	TR20	CHI	2	74.8	1.95

Date (mm/yyyy)	Drain or pond	Drain or pond ID	Matrix	Rep #	Moisture (%)	Se (µg/g dry weight)
OCT07	Trifolium 20	TR20	CHI	3	73.8	1.39
OCT07	Poe	POED	CHI	1	69.8	3.92
OCT07	Poe	POED	CHI	2	76	5.45
OCT07	Poe	POED	CHI	3	68.4	3.01
OCT07	Trifolium 18	TR18	CHI	1	79.2	15.40
OCT07	Trifolium 18	TR18	CHI	2	76.1	12.80
OCT07	Trifolium 18	TR18	CHI	3	79.6	14.5
OCT07	Trifolium 14A	TR14	CHI	1	79.9	5.40
OCT07	Trifolium 14A	TR14	CHI	2	80.1	5.40
OCT07	Trifolium 14A	TR14	CHI	3	80.2	5.31
OCT07	O	OOOO	CHI	1	78.4	4.11
OCT07	O	OOOO	CHI	2	76.2	3.62
OCT07	O	OOOO	CHI	3	79.7	4.26
OCT07	T	TTTT	CHI	1	78.5	5.89
OCT07	T	TTTT	CHI	2	78.8	6.02
OCT07	T	TTTT	CHI	3	79.9	6.49
OCT07	Z Spill	ZSPL	CHI	1	78.1	2.58
OCT07	Z Spill	ZSPL	CHI	2	77.2	2.62
OCT07	Z Spill	ZSPL	CHI	3	77.9	2.30
OCT07	Trifolium 20	TR20	DET	1	78.1	2.61
OCT07	Trifolium 20	TR20	DET	2	75.8	1.76
OCT07	Trifolium 20	TR20	DET	3	75.7	2.35
OCT07	Poe	POED	DET	1	80.3	2.44
OCT07	Poe	POED	DET	2	84.4	6.55
OCT07	Poe	POED	DET	3	81	3.74
OCT07	Trifolium 18	TR18	DET	1	80	16.4
OCT07	Trifolium 18	TR18	DET	2	81.4	13.3
OCT07	Trifolium 18	TR18	DET	3	80.8	21.7
OCT07	Trifolium 14A	TR14	DET	1	70.9	4.39
OCT07	Trifolium 14A	TR14	DET	2	78.6	5.72
OCT07	Trifolium 14A	TR14	DET	3	76.7	3.79
OCT07	O	OOOO	DET	1	73.5	4.75
OCT07	O	OOOO	DET	2	75.8	4.37
OCT07	O	OOOO	DET	3	75.2	2.54
OCT07	T	TTTT	DET	1	77.2	1.48
OCT07	T	TTTT	DET	2	71.5	1.3
OCT07	T	TTTT	DET	3	73.3	0.85
OCT07	Z Spill	ZSPL	DET	1	72.3	3.59
OCT07	Z Spill	ZSPL	DET	2	75.3	3.37
OCT07	Z Spill	ZSPL	DET	3	76.4	3.62

Table A7. Raw data for measurements of total selenium and moisture content in two surrogates of desert pupfish collected from seven intensively sampled drains in April and October 2007.

[Acronyms for the surrogate species are: SLM, sailfin molly; and GMB, western mosquitofish. **Abbreviations**: mm/yyyy, month/year; ID, identification code; Rep #, Replicate number; %, percent; µg/g, micrograms per gram]

Date (mm/yyyy)	Drain or pond	Drain or pond ID	Matrix	Rep #	Moisture (%)	Se (µg/g dry weight)
APR07	Trifolium 20	TR20	GMB	1	74.0	5.97
APR07	Trifolium 20	TR20	GMB	2	74.2	6.21
APR07	Trifolium 20	TR20	GMB	3	74.0	5.90
APR07	Poe	POED	GMB	1	76.7	8.35
APR07	Poe	POED	GMB	2	76.6	8.78
APR07	Poe	POED	GMB	3	77.7	9.49
APR07	Trifolium 18	TR18	GMB	1	75.5	17.9
APR07	Trifolium 18	TR18	GMB	2	76.4	18.1
APR07	Trifolium 18	TR18	GMB	3	76.8	20.2
APR07	Trifolium 14A	TR14	GMB	1	76.6	5.57
APR07	Trifolium 14A	TR14	GMB	2	77.0	5.50
APR07	Trifolium 14A	TR14	GMB	3	78.5	5.66
APR07	O	OOOO	GMB	1	76.8	5.66
APR07	O	OOOO	GMB	2	77.0	5.53
APR07	O	OOOO	GMB	3	76.9	5.70
APR07	T	TTTT	GMB	1	76.9	4.78
APR07	T	TTTT	GMB	2	76.2	4.62
APR07	T	TTTT	GMB	3	79.1	4.69
APR07	Z Spill	ZSPL	GMB	1	77.6	5.38
APR07	Z Spill	ZSPL	GMB	2	77.1	5.71
APR07	Trifolium 20	TR20	SLM	1	73.3	5.38
APR07	Trifolium 20	TR20	SLM	2	71.9	4.86
APR07	Poe	POED	SLM	1	80.4	10.3
APR07	Poe	POED	SLM	2	79.8	9.71
APR07	Poe	POED	SLM	3	79.6	9.73
APR07	Trifolium 18	TR18	SLM	1	75.4	13.8
APR07	Trifolium 18	TR18	SLM	2	75.1	13.8
APR07	Trifolium 18	TR18	SLM	3	74.8	12.8
APR07	Trifolium 14A	TR14	SLM	1	74.8	4.23
APR07	Trifolium 14A	TR14	SLM	2	75.8	4.29
APR07	Trifolium 14A	TR14	SLM	3	75.9	4.51
APR07	O	OOOO	SLM	1	76.4	3.85
APR07	T	TTTT	SLM	1	71.7	4.72
APR07	T	TTTT	SLM	2	72.4	4.65
APR07	Z Spill	ZSPL	SLM	1	77.3	5.03
APR07	Z Spill	ZSPL	SLM	2	75.2	4.74
OCT07	Trifolium 20	TR20	GMB	1	80.8	4.98

Date (mm/yyyy)	Drain or pond	Drain or pond ID	Matrix	Rep #	Moisture (%)	Se (µg/g dry weight)
OCT07	Trifolium 20	TR20	GMB	2	80.4	5.22
OCT07	Trifolium 20	TR20	GMB	3	81.3	5.01
OCT07	Poe	POED	GMB	1	77.3	5.89
OCT07	Poe	POED	GMB	2	77.3	5.97
OCT07	Poe	POED	GMB	3	77.9	5.44
OCT07	Trifolium 18	TR18	GMB	1	78.3	14.70
OCT07	Trifolium 18	TR18	GMB	2	78.1	14.50
OCT07	Trifolium 18	TR18	GMB	3	77.2	13.20
OCT07	Trifolium 14A	TR14	GMB	1	76.5	5.68
OCT07	Trifolium 14A	TR14	GMB	2	77.8	6.03
OCT07	Trifolium 14A	TR14	GMB	3	78.1	5.78
OCT07	O	OOOO	GMB	1	77.1	4.43
OCT07	O	OOOO	GMB	2	77.5	4.76
OCT07	O	OOOO	GMB	3	77.9	4.20
OCT07	T	TTTT	GMB	1	77.3	4.09
OCT07	T	TTTT	GMB	2	78.4	3.72
OCT07	T	TTTT	GMB	3	78.7	3.94
OCT07	Z Spill	ZSPL	GMB	1	76.8	5.49
OCT07	Z Spill	ZSPL	GMB	2	76.8	6.00
OCT07	Z Spill	ZSPL	GMB	3	76.3	5.81
OCT07	Trifolium 20	TR20	SLM	1	78.1	4.62
OCT07	Trifolium 20	TR20	SLM	2	77.9	4.65
OCT07	Trifolium 20	TR20	SLM	3	78.2	4.79
OCT07	Poe	POED	SLM	1	76.7	4.65
OCT07	Poe	POED	SLM	2	76.2	5.27
OCT07	Poe	POED	SLM	3	76.7	4.68
OCT07	Trifolium 18	TR18	SLM	1	78.2	25.1
OCT07	Trifolium 18	TR18	SLM	2	77.6	24
OCT07	Trifolium 18	TR18	SLM	3	76.9	24.3
OCT07	Trifolium 14A	TR14	SLM	1	73.3	4.41
OCT07	Trifolium 14A	TR14	SLM	2	73	3.97
OCT07	Trifolium 14A	TR14	SLM	3	73.4	4.58
OCT07	O	OOOO	SLM	1	75.3	4.21
OCT07	O	OOOO	SLM	2	75.9	3.71
OCT07	O	OOOO	SLM	3	76.2	4.5
OCT07	T	TTTT	SLM	1	75.9	4.38
OCT07	T	TTTT	SLM	2	77.2	4.36
OCT07	T	TTTT	SLM	3	77.4	4.92
OCT07	Z Spill	ZSPL	SLM	1	74.8	4.67
OCT07	Z Spill	ZSPL	SLM	2	76.3	4.16
OCT07	Z Spill	ZSPL	SLM	3	76.7	4.85

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